TABLE 1.4

TESTS OF HYPOTHESES CONCERNING ALTERED CONSUMPTION SETS

Experiment (Primary CV Commodity)	Other Substitute Good(s)	Average Value For (Standard Deviation): AMB	MB	"Accept" (Reject) Hypothesis AMB < MB	Sample Size
The National Parks Visibility Experiment (Visibility in Grand Canyon National Park)	Improved air Quality in Denver	$6.03 (7.58)	$9.20 (11.54)	Reject	64
The Hazardous Waste Experiment (Total Containment Policy for Hazardous Waste Disposal)	EPA Regulations for Five Sources of Environmental Risk	$16.07[1] (20.78)	$25.85[1] (36.43)	"Accept"	88

[1] Pooled data from Albuquerque and Houston components.

TABLE 1.5

TESTS OF HYPOTHESES CONCERNING INDIRECT INDICATORS OF VALUE

Experiment	Accept/Reject Hypothesis: SB-effects from Y: $\alpha_1 > 0$	SB-effects from N: $\alpha_4 > 0$	SB-effects from S: $\alpha_3 \neq 0$
The National Parks Visibility Experiment	Reject	Reject	Reject
The Hazardous Waste Experiment			
Combined Data	Accept	Reject	Reject
Albuquerque Study	Accept	Reject	Reject
Houston Study	Accept	Reject	Accept
New Haven Study	Reject	Accept	Reject
National Water Quality Experiment	Reject (marginal)	Reject	Reject

TABLE 1.5(A)

POPULATION CHARACTERISTICS OF STUDY PARTICIPANTS

Experiment	Average Education (Years)	Average Annual Income (000)	Average Age (Years)	Average Household Size
The National Parks Visibility Experiment[1]	15.09 (2.20)	$37.14 (16.14)	41.89 (12.91)	3.28 (1.34)
National Water Quality Experiment[2]	14.86 ( )	1.3[4] (.8)	37.22 ( )	3.26 ( )
The Hazardous Waste Experiment[3]	14.74	36.95 (2.4)	41.83 (24.30)	40.6%[5] (14.0)

[1]
[2]Table 2.2
[3]Table 3.2
[4]Table 4.2--pooled Houston, Albuquerque data.
[5]Data are for monthly take-home incomes.
Data are for percent of households with children under 18.

N: household size (number of children in household)
A: age of respondent
SB: initial, "starting" bid from CV studies

The five independent variables included in (1.6) are those commonly used for characterizations of CV respondents in terms of delineating groups of individuals with differing tastes or preferences for a given commodity. In most instances--in <u>all</u> instances in this study--multiple collinearity between Y, E and A (those with higher incomes are older and are those with more education), in which case the three variables are collapsed into one, Y. For individuals with identical preferences, higher incomes would be expected to be associated with higher values for SB. In most cases, there is no a priori basis for assigning values to α_4 and especially, α_3 (associated with household size and sex, respectively). When environmental preservation is implicit to the CV commodity, larger household sizes (number of children in households) <u>may</u> be expected to influence bids as a result of "bequest" types of motives. In cases where environmental risk is directly at issue, as in the Hazardous Waste Experiment, ones expectations for a significant influence of α_4 and, one might argue, α_3 on SB may be greater. Thus, for all experiments the following hypothesis would seem to be relevant for the ends sought in this section:

$$H_o : \alpha_1 > 0 \qquad (1.7)$$
$$H_A : \alpha_1 \leq 0 \qquad (1.8)$$

Additionally, particularly in the case of the Hazardous Waste Experiment, the following hypotheses are of interest.

$$H_o : \alpha_4 > 0 \qquad (1.9)$$
$$H_A : \alpha_4 \leq 0 \qquad (1.10)$$
$$H_o : \alpha_3 \neq 0 \qquad (1.11)$$
$$H_A : \alpha_3 = 0 \qquad (1.12)$$

(ii) Study results. Results from tests of the hypotheses (1.7) - (1.12) in the National Parks Visibility, National Water Quality and the Hazardous Waste Experiments are summarized in Table 1.5. Referring to the Hazardous Waste Experiment, as expected in data reflecting <u>valuation</u> processes, income is shown to have a significant effect on bids offered in the CVM--on the average, higher bids are associated with higher incomes.

Results are quite different for the National Parks Visibility and National Water Quality Experiments, however. For these experiments, we "accept" $\alpha_1 = 0$ for <u>all</u> demographic variables; this "acceptance" is marginal for α_1 (income) in the case of the National Water Quality Experiment (the t-statistic is 1.60 compared with a critical t-value of 1.65).

(iii) Caveats/Comments. A notable exception from the results described above for the Hazardous Waste Experiment is the relationship between SB and income in the New Haven component of the study. In the New Haven study, the variable "respondents' sex" was dominant in "explaining" the CV bid--bids from female respondents were significantly higher than

bids from male respondents. This result may be consistent with the result observed in the Houston component of this study wherein, in addition to income, the variable N--existence of children in households--was significant in "explaining" bids. Taken together, these results suggest the potential influence of maternal concern for health threats to children on CV bids which, it must be acknowledged, could reflect attitudinal as well as behavioral responses. However, as shown below, bids obtained in Albuquerque, Houston and New Haven are not different in the statistically significant sense, and when data are pooled the influences of N and S disappear, leaving income as the only variable which significantly affects the CV bids. In any case, these results should alert the researcher to the potential importance of N and S for determining contingent values for environmental commodities which affect risks to public health and safety.

One can only speculate as to the possible explanations for the lack of significance of demographic variables--particularly, income-in determining bids observed for the National Parks Visibility and National Water Quality Experiments. Referring to data in Table 1.5(A), there are no dramatic differences in population characteristics between, e.g., the Hazardous Waste sample and the National Parks Visibility Experiment sample---particularly in terms of incomes--that would account for the differing results. Marked differences in preferences/tastes within income classes between the two samples could account for the differing influences of incomes on bids, but similarities between bid and bid variances (e.g., Table 1.2) would belie that conjecture. The most probable conjecture is that omitted variables lie at the root of the non-determinateness of variables on bids obtained in the National Parks Visibility and National Water Quality Experiments. Attention is returned to this issue in later sections.

C. AGGREGATION ISSUES

In this subsection attention is turned to experimental results of relevance for the aggregation issues discussed above in A.2. In what follows, tests of hypotheses are discussed which relate to: aggregation over attributes, aggregation over commodities and aggregation over geography.

C.1 Aggregation over Attributes

Relatively little attention is given to the attributes issue per se in this study given that virtually any commodity will consist of many attributes. Extensions of the "aggregation over attributes" issue as it related to aggregating over commodities is given considerable attention below. We have acknowledged above (subsection A.4) the potential relevance of the attributes issues for a related issue: establishing criteria for the specificity of CV commodities. However, in this subsection inquiry as to aggregation over attributes is limited to a very narrow question, interest in which is admittedly pedagogic. The inquiry of interest here is the following. Earlier works have posited, as attributes to an environmental preservation commodity, commodities related to user, option,

existence and bequest preferences of individuals. Further, these studies have offered the counterintuitive conclusions that values, subsumed in preservation values, attributable to the bequest motive will account for a large proportion (more than 50 percent) of the preservation bid. Thus, as a part of this study an effort is made to provide one more test of the relationship between the bequest value (BV) and a preservation value.

The preservation value used for this inquiry is the SE value for preserving visibility in the Grand Canyon National Park obtained in the National Parks Visibility Experiment. A sub-set of study participants are asked to disaggregate, when appropriate vis-a-vis their preferences, the SB value to user, option, existence and bequest commodities; associated values are denoted UV, OV, EV and BV, respectively. We then test the hypothesis:

$$BV \geq SB/2 \qquad (1.13)$$

The value obtained for SB (sample size: 75) is $5.09; average attribute values are (standard deviation):

UV = $0.45 ($1.04)
OV = 0.67 (1.66)
EV = 1.42 (3.63)
BV = 2.54 (5.25)

Tests of the hypothesis (1.13) result in our failure to reject the hypothesis BV $\geq$ SB/2--we "Accept" the hypothesis that values attributable to the bequest attribute of the preservation commodity account for more than half of the aggregate value for the preservation commodity.

C.2 Aggregation over Commodities

(i) Motivation and Hypotheses. As noted above, the commodity aggregation issue is an extension of the attributes issue inasmuch as if, analogous to the "mental accounts" notion, bids for any one commodity (e.g., air quality in the Grand Canyon National Park) are attributable to a more aggregate commodity (e.g., air quality in the U.S.), the former, more disaggregated "commodity" is an attribute of the more aggregate commodity.

Given the importance of this issue, discussed above in A.2, six hypotheses are tested which relate to the various, potential dimensions of the commodity aggregation issue. These hypotheses, and their respective notations, are described as follows.

We begin with the question: Is the CV bid for a specific, disaggregated CV commodity applicable, in fact, to a more aggregated commodity of which the specific commodity might be considered a priori as a substitute? This question might also be posed as: Is the CV value for a disaggregated commodity attributable to something akin to a "mental account," a component of which is the specific commodity? Five hypothesis, for which use data drawn from the National Parks Visibility and National Water quality Experiments, are designed to speak to this (these) question(s).

1. Define VG as the CV bid for preserving visibility in the Grand Canyon National Park; VG(R) is the bid for the same commodity when individuals simultaneous bid for preserved visibility in the Grand Canyon National Park and preserved visibility in five other "regional" national Parks (the bid for which is VR). If the Grand Canyon National Park visibility "commodity" is distinct from that associated with visibility in other parks, the following null hypothesis would hold.

$$H_o : VG = VG(R) \quad (1.14)$$
$$H_A^o : VG \neq VG(R) \quad (1.15)$$

Define VG (all parks) as the contingent value for the Grand Canyon National Park visibility commodity formulated when the individual considers the preservation of visibility in all National Parks. Again, if the Grand Canyon National Park commodity is distinct from the more aggregate, "all parks" commodity, the following null hypothesis would hold (assuming 1.14).

$$H_o : VG(R) = VG(\text{all parks}) \quad (1.16)$$
$$H_A^o : VG(R) \neq VG(\text{all parks}) \quad (1.17)$$

Let NWQ be the contingent value for improvements in national water quality, NW(A)Q is the same value when individuals consider improvements in national air quality in bidding for improvements in national water quality. If one's value for improvements in national water quality is distinct from his/her value of the more aggregate commodity: air and water quality, the following hypothesis is implied.

$$H_o : NWQ = NW(A)Q \quad (1.20)$$
$$H_A^o : NWQ \neq NW(A)Q \quad (1.21)$$

Let NWAQ be the contingent value for improvements in water and air quality, a commodity which includes water quality and its associated value NWQ. The following hypothesis is implied

$$H_o : NWQ < NWAQ \quad (1.22)$$
$$H_A^o : NWQ \geq NWAQ \quad (1.23)$$

The sixth and final hypothesis tested as a part of the commodities aggregation inquiry speaks more directly to the mental accounts issue. From the Hazardous Waste Experiment, let AMB be the "adjusted" maximum bid for the total containment policy, such adjustments reflect the individuals' consideration of other environmental goods which are a priori substitutes. AMB(PG) is the adjusted bid when individuals consider other, substitute, environmental goods (as for AMB) as well as other "Public Goods" that are not environmental in nature, viz., improved highway safety and national defense. All else equal, since AMB (PG) involves consideration of an expanded consumption set vis-a-vis AMB, we would expect AMB(PG) > AMB, if improved highway safety and/or national defense are "consumed." If, on the other hand, non-environmental goods are ignored in the process of valuing environmental goods, a la an "environmental safety account," we would expect AMB = AMB(PG)--the introduction of non-environmental "PG" goods

leaves unaffected the valuation of the environmental good. Therefore, the last hypothesis of interest here is:

$$H_o : AMB = AMB(PG) \quad (1.24)$$

$$H_A : AMB \neq AMB(PG). \quad (1.25)$$

(ii) Study Results. Results from tests of the hypotheses (1.14) - (1.25) are summarized in Table 1.6. Beginning with the more disaggregate good, preserved visibility in the Grand Canyon National Park, "acceptance" of hypotheses 1 and 2 (Table 1.6) suggest the distinctness of the environment commodity: valuations of five other regional parks and valuations of all other national parks does not affect the individuals' valuation of the specific commodity: preserved visibility in the Grand Canyon National Park.

Results from hypothesis 3 (Table 1.6) are troublesome, however. The sum of CV values for preserved visibility in the Grand Canyon National Park (VG(R)) and for preserved visibility in five other regional national parks (VR) is not less than the CV value for improvements in national air quality (NAQ). Indeed, we accept the hypothesis VG(R) + VR = NAQ--CV values for national improvements in air quality are captured in bids for preserved visibility in six national parks.

A similar pattern is found when attention focuses on more aggregate commodities. The bid for improved national water quality is unaffected by introducing improved national air quality as a commodity (hypothesis 4 in Table 1.6). However, the bid for improved national water quality (NWQ) is not less than the bid for improvements in national water and air quality (NWAQ). Indeed, NWQ = NWAQ is accepted--the value for improvements in water and air quality is captured by the bid for improved water quality alone.

Finally, in an earlier experiment (Table 1.4) it was shown that the introduction of other environmental goods significantly lowered the bill for the Hazardous Waste Commodity, i.e., MB > AMB. From hypothesis 6 (Table 1.6), however, the further introduction of non-environmental goods (AMB(PG)) does not affect the bid--we "accept" the hypothesis AMB = AMB(PG). Seemingly, individuals ignore non-environmental goods in their valuation of an environmental good (or a set of environmental goods.

(iii) Caveats/Comments. One might explain away the results of hypotheses 3 and 5 (Table 1.6) by appealing to such things as problems associated with individuals' ability to grasp the meaning of aggregate commodities such as national environmental quality improvements. The authors are inclined to view these results at face value. The implications are that real problems may exist in the attribution of CV measure to specific, disaggregated commodities--bids for a specific commodity may in fact measure maximum willingness to pay for a broader, more aggregate commodity. The notion that individuals may view environmental improvements in aggregative, "gestalt" (or "mental account") terms is supported by results from hypothesis 6 in Table 1.6: individuals seemingly ignore non-environmental goods in their valuations of an environmental good.

Our finding of evidence which suggests the potential for commodity bids that apply to broader commodity classes is not altogether negative vis-a-vis the ultimate potential of the CVM for use in benefits assessments. One sees in these results an interesting parallel with Bishop and Heberlien's attitude-behavior dichotomy. If, in the introspective valuation process, individuals do indeed tend to think in terms of classes of general environmental goods--or the environment as a whole--this need not relegate CV measures to a role of simply indicating attitudes. Values used in hypotheses 3, 5 and 6 were used in hypotheses tested in subsection B.l above wherein reasonably persuasive conclusions are suggested as to the argument that individuals do view offered CV bids within the context of values, rather than attitudes, Thus, CV measures may remain as values for classes, or accounts, of (relevant to) environmental improvements.

Moreover, results from hypotheses 1, 2 and 4 (Table 1.6) are relevant for efforts to deduce implications from hypotheses 3, 5 and 6. Results from hypotheses 4 and, particularly 1 and 2 suggest that at relatively disaggregate levels, individuals can and do differentiate between environmental commodities: the introduction of "new" commodities that are defined at (approximately) the same level of aggregation does not effect individual valuations of a specific commodity.

It is the authors view that this mix of results concerning the commodity aggregation issues defines a clear challenge for future research designed to further the development of the CVM. Much more work is required in efforts to design the CV instrument in such a way that individual attention is focused on environmental commodity of interest within a context which includes the more general commodity-class within which the specific commodity may be a component. As an example, it may be necessary in the elicitation of bids for a commodity X to present to and discuss with the study participant a large class of other environmental goods; it may be necessary to seek simultaneous valuations of components in this reasonably exhaustive menu of environmental goods (and other public goods?). We recognize the implications of these conclusions for potential size of the CV instrument as well as the costs of implementing the CVM. In light of this subsections findings, taken together with subsection A.1's discussion of the importance of the commodity-aggregation issue (particularly with regards to the question: can one sum CV values), these costs may be unavoidable if the CVM is to generate values which can be defensibly used as benefit measures attributable to a specific commodity.

C.3 Aggregating over Geography

(i) Motivation and Hypotheses. The final set of aggregation issues to be addressed in this subsection relates to aggregation over geography. Interest in this issue is motivated by the ultimate need to aggregate geography-specific CV values to national values in cases where CV measures are to be used for comparisons of national benefits and costs associated with a particular policy. In such cases, one must be concerned with the extent to which commodity values vary across regions of the U.S. and the determinants of such variations. Thus, if $D_1, \ldots, D_n$ are variables which serve as proxies for preference-related population

TABLE 1.6

TESTS OF HYPOTHESES RELATED TO AGGREGATION OVER COMMODITIES

Hypothesis	Accept/Reject
1. VG = VG(R)	Accept
2. VG(R) = VG(All Parks)	Accept
3. VG(R) + VR < NAQ	Reject
4. NWQ = NW(A)Q	Accept
5. NWQ < NWAQ	Reject
6. AMB < AMB(PG)	Reject

characteristics which are established a priori (e.g., income, education, etc.), one is concerned with the influence of the D_i's on commodity valuations. Problems can arise as different sets of the D_i's are found to be of importance in explaining bids or each of a few sites in which the CVM is applied. Such findings could necessitate potentially large, costly expansions in the number of site-applications of the CVM for national aggregation purposes. Thus, ideally the same set of (hopefully, a few) D_i's are found to be of consequence across regions of the U.S.

The geography-aggregation issue is addressed in this study via the one experiment which involves multi-locational applications of the CVM, viz., in the Hazardous Waste Experiment which involves application of the CVM in three metropolitan areas: Albuquerque, New Mexico (ABQ); Houston, Texas (HT); and New Haven, Connecticut (NH). The results are therefore limited inasmuch as no basis exists for extrapolating findings of this experiment to all other CVM applications which involve different CV commodities. The experiment does serve as an interesting case study, however, and provides, at a minimum, a basis for reference in future experiments concerning the geography-aggregation issue.

As discussed above (see Table 1.5), tests of the influence on bids of selected variables demonstrated the dominance of income as a determinant of bids. The remaining issue is the relationship between income-adjusted bids obtained in the three cities/regions; i.e., are these geography-specific bids different and, if they are, what explains the differences. Defining MB_A, MB_H and MB_N as "maximum" bids for Hazardous Waste commodity of the Hazardous Waste Experiment obtained in Albuquerque, Houston and New Haven, respectively, the hypothesis of interest is then expressed in the following

$$H_o : MB_A = MB_H = MB_N \quad (1.26)$$
$$H_A : MB_A \neq MB_H \neq MB_N \quad (1.27)$$

(ii) Study Results. Results from tests of the hypotheses (1.26) and (1.27) are described below in subsection IV's Table 4.13 and 4.17. The null hypothesis 1.27 is "accepted"-- there is no statistically significant difference between CV values for the Hazardous Waste commodity obtained in the three regions.

(iii) Caveats/Comments. Aside from the implicit caveat mentioned above concerning generalizing these results to other CV studies with different CV commodities, an additional observation warrants mention.[35] We have acknowledged the lack of a theoretical basis for necessarily expecting bid-differences across studies other than those attributable to variables included in regression analyses described above in subsection B.3. Indeed, hypothesis (1.26) and (1.27) represent heuristic inquiry as to the possible existence of unexplained bid-differences that would then necessitate additional theoretical and empirical attention. In this regard, one must recognize the potential importance for CV values attributable to the Hazardous Waste commodity that can be seen as obviously relevant on theoretical as well as a priori grounds, viz., proximity to a waste disposal site. Close proximity to a known disposal site for hazardous wastes is not an issue in any of the three sites used in the Hazardous

Waste Experiment. Differences in the nature of public concern for the general hazardous waste disposal issue exists in the samples and, from the above, such differences seemingly do not affect bids. For example, concern in Albuquerque focuses on city wells in the South Valley which were recently found to have been contaminated by "improper" dumping of hazardous industrial wastes; potential dangers from the disposal of wastes from petrochemical industries were of concern to Houston residents. But in none of the areas was a well-defined waste disposal site per se an issue of concern.[36]

D. INDIVIDUAL PERCEPTIONS OF CV COMMODITIES

A better title for this section might well be "problems in perceiving CV commodities." Clearly if an individual does not understand what he or she is bidding for (the nature of the commodity itself, or how useful that commodity might be at the moment or over time to the individual, then the contingent valuation method will produce biased or meaningless results. Although closely related to the aggregation issue in several respects--one could reinterpret most of the preceding section along perception lines--the focus in this section will be placed on three examples drawn from the experiments of potential or actual perception problems.

The first example is drawn from the National Parks Visibility Experiment. Two separate estimates of user values for improved visibility at the Grand Canyon can be made from the CV results of this study. First, an estimate of this value can be made from daily bids collected through increased entrance fees on the day of a hypothetical visit. Taking the number of visitor days per year times the average bid per day for an increase in visibility gives a rough estimate of annual total user benefits. A second approach is to use CV estimates of the total value of preserving visibility at the Grand Canyon collected through increased electric utility bills, where individuals are asked to then disaggregate this bid into components consisting of user, option, existence and bequest values. Individuals were able to ascertain that user value "should" be the smallest of the component values, giving average values of about $.45 per month versus a total preservation value (sum of the components) of $5.09/month. If this ratio of .0884 to 1 obtained from a Denver sub-sample were to hold for the nation, it would imply a national user value bid for preserving visibility at the Grand Canyon of $309 million per year (based on annual total preservation value of $3.5 billion as described in Chapter II). The daily bid estimates, on the other hand, imply a national bid of only $10 million dollars per year. This inconsistency suggests the possibility of a fairly severe perception problem possibly associated either with radically different payment methods, or with an inability to break down an aggregate bid into components where one of those components is very small. For example if the component user bid were to agree with the daily entrance fee bid, the former would have to have averaged 1½¢ broken out of a total preservation value averaging over $5! The "scaling" of the component bid approach is, in retrospect, almost ridiculous and obviously likely to induce a perception problem as compared to the daily entrance fee approach.

The second example of a perception problem occurred in the Hazardous Waste Experiment. A large fraction of respondents bid the same amount for a policy which provided a 50 percent probability of hazardous waste containment as for a policy which provided a 100 percent probability of containment. One explanation for this result is the simple fact that a large fraction of the adult population in the United States has no formal concept of what a probability is. Thus, the specification of the commodity could have been meaningless to a large fraction of the respondents. Political scientists often employ filter questions to remove meaningless answers to survey questions. In the case of the Hazardous Waste Experiment, a few questions to determine if the respondent understood the meaning of a simple probability would have improved the interpretation of the results dramatically.

Finally, the Ozone Experiment provides a more positive example relating to perceptions. Daily CV bids for reduced ozone levels do appear to be roughly consistent both with previous CV studies using monthly bids and with capitalized air quality values revealed through analysis of property values. In contrast to the National Parks Visibility Experiment, no scaling problem appeared to be present since daily bids fell in the range of a few dollars, monthly bids in the range of tens of dollars, and annual capitalized values in a range of hundreds of dollars.

E. OTHER EXPERIMENTAL ISSUES

The final set of issues addressed in the Methods Development project are methodological in nature. Two sets of issues are addressed: the "marginal" nature of CV values and the nature of differences in CV values obtained from alternative solicitation modes.

E.1 CV Values as Measures of Marginal Values

(i) Motivation and Hypotheses. Related to the attitude vs. intended behavior as well as the commodity aggregation issues which has appeared repeatedly in our earlier discussions, if the CV measure is indeed couched in value terms (as opposed to an indication of "I like a clean environment") the CV measure must be a marginal valuation. This is to say that there now exists an environmental "state" and an existing "state" of EPA regulations. The existing state of environmental quality is a good for which people now pay a "price" in terms of higher taxes (compared with, e.g., pre-EPA days; such taxes pay for research, policy formulation and enforcement activities by the EPA and other agencies) and higher prices for current purchases of goods and services (e.g., pollution abatement costs passed on, in whole or part depending on demand/supply elasticities, to consumers). An environmental improvement--the substance of CV commodities--represents a (usually) small change in the environmental state. Obviously then the CV measure must be attributable to the appropriate margin rather than to the environmental state per se.

As stated above, this "marginal" issue is an alternative way of stating the commodity aggregation issue: does the CV measure apply to the

specific commodity (a marginal change in the environmental state) or to a more aggregate commodity (the environmental state per se). There is one important difference, however, which accounts for the authors distinct treatment of the "marginal" issue. This difference lies in viewing the commodity aggregation with a precise value context: basic to this line of inquiry is the individuals' cognizance of the existing environment state and their costs for maintaining that state in offering values for improvements--changes--in environmental quality.

The following procedure is used in addressing the "marginal" issue. In the New Haven component of the Hazardous Waste Experiment, a discussion of the existing state of environmental regulations and environmental quality (air, water quality, etc.) preceded willingness to pay questions. Half (44) of the New Haven respondents were given additional information, viz., an estimate of the monthly amount now paid by similar (to the respondents') households for the existing environmental state via higher prices and taxes. Questions expressed by two hypotheses are of interest for this experiment. First, are individuals cognizant of the existing environmental state in offering bids for marginal changes (environmental improvements)? Evidence suggestive of such cognizance would follow from a demonstration that bids obtained without explicit discussions of the environmental state (the SB values obtained in Albuquerque and Houston) are not significantly different from those obtained with such discussions (the SB value obtained from 44 New Haven respondents); i.e., with SB_N the New Haven starting bid and SB_{AH} the Albuquerque (or Houston) starting bid, cognizance of the existing environmental state is suggested by "acceptance" of the hypothesis $SB_N = SB_{AH}$. Of course, this hypothesis was tested above in subsection C.3 and the hypothesis was "accepted." We then have evidence suggestive of individual awareness of the existing environmental state in their formulation of CV bids.

Secondly, are individuals' cognizant of their present expenditures for the existing environmental state in their formulation of a CV bid? Defining SB_1 (SB_2) as the average starting bid by individuals who are (are not) given estimates of their current expenditures for the environmental state, an affirmative answer to this question is suggested by the following hypothesis:

$$H_o : SB_1 = SB_2 \qquad (1.28)$$

$$H_A^o : SB_1 \neq SB_2 \qquad (1.29)$$

(ii) Study Results. Results from tests of hypotheses (1.27) and (1.29) are summarized in Table 1.7. The null hypothesis is "accepted": CV bids are seemingly unaffected by explicit information as to current outlays for the existing environmental state.

(iii) Caveats/Comments. Results from the Hazardous Waste Experiment are consistent with the proposition that CV values are appropriately "marginal" in nature--in offering CV bids, individuals are cognizant of the existing environmental state and the income sacrifice required to maintain that state. However much encouragement one might draw from this observation, it must be recognized that a demonstration that CV values are

TABLE 1.7

TEST OF THE MARGINAL BID

Experiment	Average Value For (Standard Deviation) SB_1	SB_2	Accept/Reject Hypothesis $SB_1 = SB_2$	Sample Size
The Hazardous Waste Experiment	$13.34 (17.22)	$17.52 (20.55)	Accept	88

appropriately marginal does not necessarily diminish the commodity-aggregation problem. Thus, while 2 bid for an environmental improvement may be a marginal valuation, the issue as to how individuals view the marginal environmental change--a marginal change in aggregative "environmental quality" or the change represented by the CV commodity-- remains as an open question.

E.2 Solicitation Modes for Obtaining CV Measures

(i) Motivation and Hypotheses. An important methodological, or logistical, issue for implementation of the CVM concerns the solicitation mode to be used in administering the CV instrument. Three obvious alternatives exist: administering the CV instrument by mail, by going door-to-door in selected neighborhoods (or to selected houses) and by the intensive process by which pre-arranged appointments are established with selected households; these methods are referred to as mail, extensive and intensive methods (or solicitation modes), respectively. Ones motivation for interest in solicitation modes is a practical one: cost; costs per completed instrument are most often much lower for the mail method than for the extensive method and most expensive is the intensive method.

The central issue here is the question as to the existence of rationale which would lead one to prefer one solicitation mode over another; in other words, does one get different, or "better," results using one method over another and, if so, what might explain the differences?

The following method is used in this study in efforts to address these questions concerning solicitation modes. In the Houston component of the Hazardous Waste Experiment, CV values for the Hazardous Waste commodity are obtained using both the intensive and extensive methods. Defining PB_E and PB_I as CV values obtained from extensive and intensive methods, respectively, we then test the hypotheses:

$$H_o : PB_E = PB_I \quad (1.30)$$
$$H_A : PB_E \neq PB_I \quad (1.31)$$

In the Ozone Experiment, CV measures for the Ozone commodity are obtained using both the extensive and mail methods. Defining Z_E and Z_m as Ozone bids obtained from extensive and mail methods, respectively, the following hypotheses are tested:

$$H_o : Z_E = Z_m \quad (1.32)$$
$$H_A : Z_E \neq Z_m \quad (1.33)$$

(ii) Study Results. Results from tests of hypotheses (1.30) - (1.33) are given in Table 1.8. The null hypotheses (1.30) and (1.32) are "accepted"-- there is no statistically significant difference between CV values obtained from mail, extensive and intensive solicitation modes.

(iii) Caveats/Comments. Some potential for a fallacy of composition--a deductive "leap"--exists in any conclusion that the three solicitation modes yield identical results. All three modes were not used

TABLE 1.8

TESTS OF HYPOTHESES CONCERNING SOLICITATION MODES

Experiment	Mean Value of Bid (Standard Deviation) PB_I	PB_E	Z_E	Z_m	Accept/Reject Hypothesis $PB_I = PB_E$	$Z_E =$	Sample Size
The Hazardous Waste Experiment	$17.06 (22.40)	$7.05 (8.44)			Accept		113
Ozone Experiment			See Chapter 5			Accept	___

in a single experiment, in which case appeal to some form of transitivity is required if one is to "conclude": I = E, E = M, ergo I = M. Obviously, the link $PP_E = Z_E$ is missing for the appropriate deduction: $PB_i = PB_E$, $PB_E = Z_E$, $Z_E = Z_m$. Nonetheless, the results of hypotheses (1.30) - (1.33) can be viewed as encouraging in their potential promise for considerable flexibility in the investigators' choice of a solicitation mode.

Finally, results reported in Table 1.9 must be viewed within the context of data concerning response/contact ratios which are given in Table 1.7. These data suggest the potential for respondent biases in our CV results as discussed above in A.4. The large percent of individuals contacted by mail/telephone that did not participate in the study raises questions not addressed in this study as systematisation biases in terms of characteristics of individuals who do and do not participate. While the response/contact ratio for the Hazardous Wastes' extensive (door-to-door) study is relatively higher--33 percent--underlying this ratio is the fact that, in many of the socio-economic neighborhoods included in the study, the response rate is zero (see Table 4.3 in subsection IV).

F. CONCLUSIONS

F.1 Review of Study Results

Having discussed the nature of, and results from, the multi-facited experiments included in the Methods Development Project, it is now desirable to bring these many results together in an effort to describe what has been learned about the CVM and the implications of this knowledge for assessments of the CVM in terms of its potential as a method for estimating benefits attributable to environmental inprovements. Before giving attention to these important issues, it will be useful to briefly review what has been learned in the Project; thus, a brief statement of these "lessons" follows.

1. Are CV values for environmental improvements consistent with those derived from the Hedonic Property Value Method?

- Both the CV Method and the Hedonic Property Value Method produce order of magnitude estimates, not precise estimates, due to the uncertainties inherent in each technique.
- Within this order of magnitude range CV and Hedonic Property Value Methods give consistent benefit estimates.

2. Are CV responses couched within the context of value as opposed to attitudes?

- CV measures are consistent with values formulated within a budget-constrained process of preference research.

TABLE 1.9

RESPONSE/CONTACT RATIOS FOR EXPERIMENTS

Experiment	Number of Contacts	Number of Responses	Response/Contact Ratio
The Hazardous Waste Experiment			
Extensive[1]	75	25	.33
Intensive[2]	1,147	92	.08
Ozone Experiment			
Mail Method	--	--	.03-.10[3]
Extensive	--	--	.24-.56[3]

[1] Door-to-door contacts in Houston.
[2] Telephone contacts in Houston.
[3] Range of ratios in communities surveyed.

- in 2 out of 3 experiments, bid formulation in CV studies is consistent with auction-like (demand penudrum) processes wherein individuals focus on maximum willingness to pay only as market-entry costs rise.

- lower CV bids resulting from altered consumption sets are consistent with axioms from received theory; however, questions remain as to the extent that altering the consumption set will significantly effect CV bids.

- household income, and other household characteristics, are not shown to be significant determinants of CV values.

- CV bids are seemingly formulated within a context where individuals are cognizant of the existing environmental state as well as present expenditures for maintaining that state; thus, contingent values are seemingly "marginal" in nature.

3. Are contingent values appropriately commodity-specific or may they be attributable to some more aggregative commodity?

- Commodity-specific bids for relatively disaggregated commodities are seemingly unaffected by the introduction of substitute goods which are at the same level of disaggregation.
- However, bids for aggregate commodities (e.g., improvements in national air quality or air and water quality) are not significantly different from bids for disaggregate commodities, which suggests that commodity-specific bids may be attributable to more aggregative goods. This result is consistent with the "mental accounts" notion.

- Again supportive of the mental accounts notion, individuals seemingly ignore non-environmental goods in their formulation of values for an environmental good.

4. Are bid changes in response to changes in environmental risk consistent with those derived from Expected Utility Theory?

- Lower probabilities of hazardous waste containment are not associated with lower CV values, which is inconsistent with axioms derived from Expected Utility Theory.

- Higher (implicit) damage probabilities are not associated with higher CV values, which is inconsistent with axioms derived from Expected Utility Theory.

- However, the credibility of these results is seriously weakened by weakness in the design of CV instruments used in deriving data for testing these hypotheses as well as by a myriad issues related to individual perceptions of risk which are not addressed in this study.

5. Are individual perceptions of, and offered value for, CV commodities consistent?

- Perception of values may be affected by scaling problems.

- Perception of values under uncertainty may be poor when individuals fail to understand concepts of probability.

6. Are included variables sufficient for explaining bid-differences across regions of the U.S.?

- Income-adjusted bids for the Hazardous Waste commodity are shown to be invariant with respect to study locations.

7. Are CV measures affected by choice of solicitation mode?

- Significant differences in bids are not identified between those derived by intensive and extensive modes and by extensive and mail modes.

F.2 Conclusions: The Substance of the Contingent Valuation Method

Based on study results summarized above, one immediately obvious conclusion is suggested in terms of the viability of CV values as measures of social benefits attributable to environmental improvements: considerably more developmental research is required if the state of the arts for the CVM is to advance to the level where it may produce defensible benefit estimates. However, while this conclusion follows from the problems associated with CV values identified in this work, these problems should not overshadow the positive findings reported in the study.

Looking to the positive side, results from validation studies (groups 1 and 2 above) provide a reasonably sound basis for concluding that CV measures are couched within the context of value. The juxtaposition of offered CV values to budget-related trade-offs, their responsiveness to altered consumption sets and the auction-like process by which CV values are re-defined and re-formulated in response to increasingly stringent market-entry conditions combine to suggest that in formulating CV bids, individuals follow the process of preference research indicative of, or at worst consistent with, intended behavior. All else equal, these results should increase the palatability of ones' acceptance of a CV value as a meaningful measure of maximum willingness to pay. While of interest in their own right, conclusions as to the equality of CV bids across regions and their insensitivity of solicitation modes buttresses these arguments as to the value-content of CV measures.

However, if one accepts the value content of the CV measure, unanswered is the starkly critical question posed by study results as to what is being valued in the CV study. Study results provide good reason to question the applicability of a studys' CV measure of "value" to the studys' specific commodity. Rather, the valuation may well apply to some more aggregate commodity--some aggregate Commodity "account." To the

extent that this commodity-aggregation issue is real--and, however casual, the research community's general reluctance to add commodity-specific values would suggest that it is real--implications for questions requiring research are immediately apparent. First, we must understand, define and delineate the aggregate commodity (or mental account) relevant for any specific environmental improvement. Secondly, experiments are required for testing means by which values which are appropriately attributed to the aggregate commodity can be allocated to the disaggregated commodities which are the "attributes" of the aggregate commodity.

A final problem of substantial substance identified in the study is the perplexing role of individual perceptions in their formulation of CV values.

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7. See, as but a few examples,

8. Here we simply acknowledge the existence of the debate as to the appropriateness of summing indicators of individual utilities; for discussions of this topic, see Goldman and Uzawa (1964) and Katzner (1970).

9. See, e.g., Bishop and Heberlein (1979), Hammack and Brown (1974).

10. The authors express their appreciation to Dr. William Desvousges, Research Triangle Institute, for useful remarks in these regard.

11. Desvousges, W. H. and Smith, V. K. The Basis for Measuring the Benefits of Hazardous Waste Disposal Regulation (Raleigh, Research Triangle Institue (1982).

12. Mitchell, Robert, et al. (1981).

13. The CV study for hazardous waste disposal was, initially, a case specific study required for compliance with an EPA Cooperative Agreement. Its later extensions and inclusion as a part of the Methods Development project were based on the following considerations.

14. Kahneman and Tversky, Science, January, 1982.

15. Slovic, et al. (1977).

16. Ibid; see, also, Kahneman and Tversky (1979), Starr, Rudman and Whipple (1976) and Fairley (1975).

17. See Section IV.B.

18. Schulze et al., Land Economics (1981); see, also, Randall, A., et al., "Contingent Valuation Survey for Evaluating Environmental Assets," Natural Resources Journal (June. 1983).

19. Ibid, p. 170.

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27. For example, Slovic et al. (1977), Op. Cit.

28. See, for example, the "risk denial" notion developed in Slovic et al., (1977), Op. Cit.

29. Cummings et al., 1981, Op. Cit., Chapter 8.

30. Ibid

31. Lancaster, K. (1966).

32. Schulze, et al., 1981 (Land) Op. Cit. 33. Bishop and Heberlein (1974), see, also, Hoehn and Randall and Randall et al. (1983), Op. Cit.

34. We use the "loose" expression of accepting H_o for expositional simplicity for use in the following tables.

35. The authors are grateful for comments offered by Dr. W. H. Desvousges in this regard.

36. The obvious question which arises in this regard is why the study design did not include areas in close proximity to disposal sites. During the design stage of the Policy Bid experiment, the researchers included such sites. For reasons not totally clear to the authors, these choices were rejected by the grant monitor; the Albuquerque, Houston and New Haven sites were those approved by the monitor.

CHAPTER II

THE NATIONAL PARKS VISIBILITY EXPERIMENT

A. VARIATIONS IN FRAMING

A.1 Introduction

The credibility of the contingent valuation approach hinges upon the stability of bids offered for a nonmarket good. Stability, in turn, depends on the extent to which the respondents are induced to research their preferences. The depth of a respondents research into his/her preferences depends on two critical factors: (1) how well the nonmarket good is specified; and (2) the quality of the survey design.

As suggested previously, recently completed research implies that results between benefit estimates for public goods derived from hedonic methods and those derived from contingent valuation methods (Brookshire, et al., 1982; Cummings, et al., 1978) are approximately equivalent. Two criticisms of the contingent valuation technique have been raised. First, that respondents could casually bid any amount, without weighing the opportunity costs implicit in their bids; and second, the bids obtained may possess an upward bias because contingent valuation surveys heretofore have sought bids for individual or single public goods in isolation, rather than within an environment in which other public goods may, realistically, have to be purchased as well.

A third issue which has been raised is Randall's prediction that the individual's initial bid, taken from a payment chart, may not fully capture his maximum willingness to pay.

The goal of the experiment outlined in this section is investigation of the relationship between bid stability and good specification, as well as effectiveness of alternative methods for inducing "preference research".

An outline for the remainder of this section is as follows: sub-section A.2 presents the survey design, sub-section A.3 reports on the results of the survey, and finally, conclusions are given in sub-section A.4.

A.2 Survey Design

The survey instrument is employed to address a multiple set of issues in the problem of valuing nonmarket goods. The survey was structured into four sub-experiments. In each of these, bids were solicited for the same well-defined public good, visibility at the Grand

Canyon National Park. Specification of this good was assured by presenting all respondents with the same set of photographs of known visibility levels at particular sites as well as identical supplementary information. Variable across the four sub-experiments were: (1) the presence of budget constraints, (2) introduction of other well-defined public goods, (3) addition of a vaguely defined public good, and (4) use of an iterative procedure to elicit any differential between initial bid and the maximum willingness to pay.

Common to all four surveys were the following steps. The surveys were initiated with interviewers introducing themselves and presenting the purpose of the study. After an introduction, a brief explanation of the causes of poor visibility was given. Next, photographs of the sites were shown to the respondents. These photographs were arranged in five columns representing visual air quality ranging from very poor in Column A to very good in Column E with Column C depicting the average level of air quality. At this stage of the interview, data gathering began. All four surveys began with questions concerning frequency of the household's past and future park visitation. Beyond this point, divergence between the four surveys occurs.

The First Experiment began by asking people how much they would be willing to pay per month as an increase in their electric utility bills to preserve the average level of air quality (Column C) rather than having it deteriorate to the level shown in Column B. This initial bid was obtained by handing the respondents a payment chart with different dollar amounts listed and asking him/her to select one of the figures. This bid is called the initial willingness to pay bid. Now, to test Randall's hypothesis that the initial bid does not fully capture Maximum willingness to pay, participants were asked the following question. "Suppose that with all households paying your initial bid, this amount of money was insufficient to permit preservation of visibility level C at the Grand Canyon, would you be willing to pay one dollar more?" If the answer was positive, the question was repeated. This process is iterated until the participant will pay no more, and the total bid thus obtained is termed the "maximum willingness to pay". To test whether the individual's true preferences have been captured, we introduced into the consumer's opportunity set, the option of buying another familiar, hence well-defined, public good and observed whether the tendency to buy quantities of this newly introduced good modifies the respondents maximum willingness to pay for visibility in the Grand Canyon. Since this survey took place in the relatively smoggy-city of Denver, Colorado, we chose to introduce an improvement in air quality in Denver as the other, familiar, well-defined public good. This was accomplished by asking the respondents the following question. "Suppose that another surveyor came tomorrow and asked how much you would be willing to pay to see air quality improved in Denver, would you still be willing to pay the maximum amount you have indicated for the Grand Canyon?" If the respondent did not alter his previous bid, that fact may be taken as evidence that his true preferences have been revealed. If, on the other hand, the individual's bid changes when this other public good (air quality in Denver) is introduced, then this would imply that the dollar amount

obtained through the Bidding Game fails to correspond with his/her true willingness to pay, i.e., the respondent's true preferences.

The Second Experiment differed from the First in two respects. First, the question regarding the other well-defined public good, local air quality, was deleted from the survey. Second, before the bidding process began, the individual was confronted with his budget constraint. This was accomplished by (1) asking the household to reveal its monthly net income and (2) requiring this figure to be allocated between five categories: housing/utilities, food, recreation/entertainment, transportation, savings, and finally other expenses. Only after giving this budget information was the respondent handed the payment chart and asked to select his willingness to pay to preserve the average level of visibility in the Grand Canyon through increases in his monthly electric utility bill. Once this figure was obtained the iterative procedure was employed to elicit his maximum willingness to pay. At this point the individual was requested to indicate which of the expenditure categories would be decreased in order to finance his contribution to the maintenance of present air quality at the Grand Canyon. This introduction of a budget constraint was designed to confront the individual with the opportunity costs entailed by his bid, and thus to stimulate preference research. The latter is desirable because when the individual undertakes substitution out of other commodities and into air quality at the Grand Canyon, he is brought to focus in a concrete way upon his actual valuation of the public good.

The Third Experiment differs from the Second in several ways. First, the budget constraint analysis was eliminated. Second, rather than introducing visibility at the Grand Canyon by itself as the public good to be purchased, in this experiment the good offered consisted of the well-defined composite commodity made up, simultaneously, of visibility at the Grand Canyon together with visibility at five other national parks in the region, Zion, Bryce, Mesa Verde, Glen Canyon, and Canyonlands National Parks. Photographs of the various parks as well as of different pollution levels were used to assure that this composite public commodity was well-defined in the mind of the bidder. The third difference was in the introduction of an ill-defined public good, in addition to the Grand Canyon which included "all 36 of the 77 national parks in the U.S. which are threatened with significant visibility deterioration". The simultaneous other public good was introduced to observe whether the bid for preserving visibility at the Grand Canyon would be affected by the concurrent presence of other well-defined public goods. The survey question was phrased as follows: "how much extra would you be willing to pay, at most, per month as an increase in your electric utility bill to preserve current average visibility as represented by the photographs in Column C rather than have the average deteriorate to that shown in Column B. Please give two separate bids, one for the Grand Canyon and one for the other regional parklands combined". As before, the iterative procedure was employed to elicit the individual's maximum willingness to pay. The inclusion of all other threatened parks in the nation was aimed at focusing the respondent's attention on the presence of the other vaguely defined public goods present in his choice set with the goal of discovering what effects this might have on bids given for the Grand Canyon. This question was phrased: "assuming

you are willing to pay to see air quality preserved in all these other areas, would you still be willing to pay the same amounts for the Grand Canyon and for the regional parks you initially indicated?"

The Fourth Experiment was identical in all respects to the Third, with one exception. It included initial bids simultaneously for the Grand Canyon and for other well specified public goods, followed by a procedure to elicit the respondent's maximum willingness to pay, and finally it offered a chance to revise these bids after the participant's attention had been focused on the presence of air quality problems at remaining national parks for which he might want to expend some portion of his budget as well. The one difference in this experiment was the addition of the budget constraint. As in the Second Experiment, the procedure here was to solicit budget data before the bidding process was begun.

Each of the four experiments concluded by seeking the following set of socioeconomic data: home zip code, place of residence (rural, suburban, urban), education, age group, sex, size of household, whether the respondent was the primary income earner, and finally a note was made if additional information was used.

The survey was conducted in Denver, Colorado, during the summer of 1982. 172 interviews were completed, by five male/female teams, each equipped with identical picture boards. Two census tracts were chosen randomly from middle income tracts in the 1970 census data, and every household in these tracts were approached (see Table 2.1). The survey was restricted to middle income families for two reasons. First, because time and financial resources were constrained, and second, due to the limited sample size, it was necessary to hold the income variable constant, which permitted comparison of results across all four sub-surveys conducted. This restriction to middle income strata only requires qualification of any experimental conclusions. Extension of the experiment across lower and higher income brackets as well as the expansion of the sample size may permit generalization of our conclusions.

A.3 Survey Results

This sub-section presents in summarized form, the information collected in the surveys described in the preceding section. All values are means with their standard deviations in parentheses. Past and future visitation for the different sites are shown in Table 2.2. Table 2.3 presents monthly income and its allocation into the six expenditure categories mentioned above, which together with the bids are used to derive income, cross, and own price elasticities. Presented in Table 2.4 are initial and maximum bids for visibility in the Grand Canyon, with and without budget constraint, in the various contexts of the different combinations of other public goods. Included here are (1) the introduction of well defined, simultaneous other public goods as represented by preservation of visibility at the four regional national parks, (2) improvement of air quality in the Denver metropolitan area, and (3) the vaguely defined other public good, preservation of air quality throughout the entire national park system. Finally, Table 2.5 presents socioeconomic

TABLE 2.1

DESCRIPTION OF THE AREA SAMPLED FOR THE NATIONAL PARK SURVEY
DENVER METROPOLITAN AREA

community/ Area	Boundaries of the Sample	Census Tract Number[a]	% Black[b]	Mean Income[c]
Denver	West: Monaco North: Yale Ave. South: Hampton Ave. East: Syracuse	68.01	1%	17,774
Denver	West: I-25 North: Evans South: Yale Ave. East: Quebec	69.01	.05%	14,405

[a] Defined in the maps of, Census tracts Denver, Colorado Standard Metropolitan statistical Area: 1970 census of Population and Housing, U.S. Department of Commerce, Bureau of the Census Publication PHC(1.)-56.

[b] From Table P-4 "Income Characteristics of the Population: 1970," ibid.

[c] From Table P-1 "General Characteristics of the Population: 1970," ibid.

TABLE 2.2

PAST AND FUTURE VISITATION DAYS

	PAST GRAND CANYON	FUTURE GRAND CANYON	PAST ZION	FUTURE ZION	PAST MESA VERDE	FUTURE MESA VERDE	PAST BRYCE	FUTURE BRYCE	PAST CANYON	FUTURE CANYON
Experiment 1	1.02 (2.40)	2.70 (2.81)								
Experiment 2	2.17 (3.31)	4.37 (4.40)								
Experiment 3	.94 (2.68)	2.94 (3.83)	.31 (1.08)	2.26 (3.69)	1.69 (3.09)	2.94 (4.04)	.31 (1.11)	1.69 (2.35)	.49 (1.34)	1.40 (2.40)
Experiment 4	1.78 (3.36)	3.25 (2.97)	.67 (1.59)	1.50 (2.16)	1.69 (2.12)	3.08 (3.77)	.36 (1.27)	1.69 (2.55)	.49 (2.68)	1.04 (3.53)

Experiment 1 = Base survey + Maximum Willingness to Pay + Denver

Experiment 2 = Base survey with budget constraint + Maximum Willingness to Pay

Experiment 3 = Base survey with other regional national parks + Maximum Willingness to Pay + all remaining national parks

Experiment 4 = Base survey with other regional national parks with budget constraint t Maximum Willingness to Pay + all remaining national parks

TABLE 2.3

MONTHLY EXPENDITURES ($)

	INCOME* (MONTHLY)	HOUSING	FOOD	REC.	TRANSPORT	SAVINGS	OTHER
Experiment 2	1866.00 (682.72)	514.85 (310.74)	298.28 (146.19)	127.41 (111.49)	127.14 (150.45)	219.00 (202.74)	580.42 (486.61)
Experiment 4	2372.50 (1034.15)	573.97 (267.43)	306.95 (141.59)	172.50 (144.99)	129.16 (89.98)	430.69 (605.31)	765.05 (710.65)

Experiment 2 = Base survey with Budget Constraint + Maximum Willingness to Pay

Experiment 4 = Base survey with other regional national parks with budget constraint + Maximum Willingness to pay + all remaining national parks

* numbers in parentheses are standard deviations

TABLE 2.4

BIDS ($)

	INITIAL* GRAND CANYON	INITIAL REGIONAL	MAXIMUM GRAND CANYON	MAXIMUM REGIONAL	DENVER	NEW BID GRAND CANYON	NEW BID REGION
Experiment 1	5.69 (7.21)		9.20 (11.54)		6.03 (7.58)		
Experiment 2	6.77 (6.16)		10.39 (10.02)				
Experiment 3	5.21 (6.18)	5.53 (6.94)	8.31. (10.43)	9.60 (13.36)		8.03 (10.43)	9.25 (13.43)
Experiment 4	6.40 (9.07)	8.14 (11.29)	8.06 (9.61)	10.51 (13.40)		7.57 (9.19)	9.98 (13.00)

Experiment 1 = Base survey + Maximum Willingness to Pay + Denver

Experiment 2 = Base survey with budget constraint + Maximum Willingness to Pay

Experiment 3 = Base survey with other regional national parks + Maximum Willingness to Pay + all remaining national parks

Experiment 4 = Base survey with other regional national parks with budget constraint + Maximum Willingness to Pay + all remaining national parks

*numbers in parentheses are standard deviations

data which includes the number of respondents in each sub-survey, education, age, family size, income, and monthly electric utility bills.

This subsection provides statistical answers to the questions which motivated the study. Primary among our objectives was to test the credibility of the Bidding Game technique through testing the stability of people's hypothetical valuations of a public good in differing opportunity environments. Variable across these environments were both choice set and budget constraint. A further question investigated was Randall's hypothesis that initial bid will always fail to fully capture maximum willingness to pay. The appropriate statistical test for hypotheses in which the dependent variable is influenced simultaneously by several independent variables is the f-test. In the present instance we wish to determine whether the bids are influenced by different combinations of variables, including budget constraint, well-defined simultaneous other public good, vaguely defined other public goods, and iterative elicitation of maximum willingness to pay, thus the f-test is employed.

The f-test procedure is as follows: (1) formulate H_o, the null hypothesis, that the means of two different experiments are equal; (2) formulate H_1, the alternative hypothesis that the means of two experiments are unequal; (3) assuming H_o is true, the data for the two experiments are pooled. The pooled bid data becomes the independent variable in the restricted model; (4) assuming H_1 is true, the data for the two experiments should remain separate, the unrestricted model is thus formed; (5) using sums of squared errors, numbers of observations, and the degrees of freedom in both the restricted and unrestricted models, the f-statistics can be calculated; (6) finally, if this f-statistic is smaller than the critical f-value associated with the pre-selected level of significance, then the null hypothesis cannot be rejected, otherwise the alternative hypothesis is accepted.

The first test inquires into whether there existed any significant differences among initial bids obtained in the four experiments. The f-statistic in this case was .217, f-critical was 2.60 with 95% confidence. Thus, the null hypotheses (initial bids are equal) cannot be rejected.

The second test compares maximum bids across the four experiments. The calculated f-statistic was .479 and the f-critical with 95% confidence is 2.60. Thus, the null hypothesis again cannot be rejected: there is no significant difference among maximum bids across survey types.

Using the results of the first two tests, initial bids across the four experiments are pooled, as can be the maximum bids. These two aggregate quantities are now tested for significant differences. Formulate H_o the pooled initial bid is equal to the pooled maximum bid. The alternative hypothesis then is that these two quantities are unequal. The f-statistic in this case was 9.646 and the f-critical with 95% confidence was 3.84. Thus, the null hypothesis is rejected: the initial bid is not equal to the maximum bid.

TABLE 2.5

SOCIOECONOMIC DATA

	# OF RESPON.	YEARS EDUC.	ACE	HH SIZE	(X-1000) INCOME	ELEC. BILL ($)
Experiment 1	64	15.09 (2.20)	41.89 (12.91)	3.38 (1.34)	37.38 (16.14)	57.34 (29.02)
Experiment 2	35	15.60 (1.99)	37.34 (11.96)	3.09 (1.42)	22.39	47.86 (18.12)
Experiment 3	35	14.91 (2.13)	43.89 (10.98)	3.31 (1.43)	31.43 (13.68)	57.93 (27.39)
Experiment 4	36	15.83 (1.81)	38.25 (12.28)	3.00 (1.22)	28.47	53.61 (29.10)

Experiment 1 = Base survey + Maximum Willingness to Pay + Denver

Experiment 2 = Base survey with budget constraint + Maximum Willingness to Pay

Experiment 3 = Base survey with other regional national parks + Maximum Willingness to Pay + all remaining national parks

Experiment 4 = Base survey with other regional national parks with budget constraint + Maximum Willingness to Pay + all remaining national parks

* numbers in parentheses are standard deviations

The fourth test inquires whether the bids obtained for the Grand Canyon under the introduction of the vaguely defined public good is influenced by the presence of a budget constraint. The f-statistic in this case was .044, f-critical was 3.84 with 95% confidence. Thus, the null hypothesis cannot be rejected indicating that there exist no differences between bids obtained with and without budget constraint. Using the result of the fourth test we may pool bids for the Grand Canyon obtained with and without budget constraints. These bids were both made in the presence of vaguely defined other public goods. The fifth test compares this pooled bid against the previously pooled maximum bid. The f-statistic here was .912 and f-critical was 3.84 with 95% confidence. Thus the null hypothesis cannot be rejected, and we conclude that the introduction of a vaguely defined other public good had no significant effect on the bids.

The sixth and final test investigates whether the previously pooled bid for the Grand Canyon was significantly affected by the introduction of a well-defined public good, namely air quality in Denver. The f-statistic in this case was 2.59 and the f-critical was 3.84 with 95% confidence. Again, the null hypothesis could not be rejected, and we conclude that the introduction of this well-defined public good had no significant effect on the bids.

In summary the bid was not affected by the introduction of simultaneous other well-defined public goods, vaguely defined other public goods, or the budget constraint. The only variable which significantly affected the bid was the iterative procedure to elicit the maximum willingness to pay. In other words, the initial bid was not equal to the maximum bid.

A.4 Conclusion

This experiment addressed three issues. The first of which was the criticism that due to the hypothetical nature of the bidding transaction respondents could casually bid any amount without having to weigh the opportunity cost implicit in their bids. This question was tested by comparing the results obtained from two sub-surveys. One of which sought bids without a budget constraint, the other first confronted respondents with the limitations implicit in their budgets, and only then solicited bids. The results: "no statistically significant difference was observed in this case. This stability of bids, i.e., invariance with respect to the budget constraint has been rationalized as being due to the fact that the public good, visibility at the Grand Canyon, is well-defined."[2]

The contingent valuation technique has also been criticized for seeking bids for public goods singly, in isolation from an environment in which the individual would realistically have to purchase many other public goods at the same time. This criticism was tested for validity. Combinations of two familiar, hence well-defined, public goods, and one vaguely defined public good were introduced in an effort to perturb the bid offered. Statistical testing showed no significant difference in these additional goods. Again, this stability has been rationalized as stemming

from the fact that visibility at the Grand Canyon was well-defined in the minds of the participants.

The third issue tested in this experiment was Randall's hypothesis that the initial bid will fail to capture full maximum willingness to pay. Initial bids were solicited, then an iterative procedure was employed to elicit maximum bids. Statistical testing of these two bids showed that the maximum bid was significantly greater than the initial bid in all cases.

The Bidding Game technique will be credible, first because the good is well-defined, and secondly because of a sound survey design. These two factors contribute to the inherent stability of all elicited bids. The experiments which we have conducted have statistically borne out that the bid responses were not altered significantly when adding these additional constraints (as explained earlier in experiments 1-4).

B. COMPONENT VALUES

B.1 Introduction

Up to this point we have been using the Contingent Valuation Technique to obtain measures of the value of preserving present visibility levels at the Grand Canyon. The phrase "Preservation Value" has been employed to denote the value placed, via the bids, on the public good. Krutilla (1967) suggested that benefits of preserving an environmental good can be sub-grouped into option benefits, existence benefits, and bequest benefits; in addition to benefits in actual use.

In this chapter the bids obtained for preservation of visibility at the Grand Canyon are broken down into the above categories in an effort to weigh their relative magnitudes. This will provide empirical evidence on the monetary significance of these values to assist in the development of environmental policy. Schulze, et. al. (1981) found that existence value surprisingly swamped the user value. Although this experiment was designed differently from Schulze, et al., but a comparison of the results obtained in these studies is required.

The remainder of this section is structured as follows: The survey design is presented in sub-section B.2. Sub-section B.3 reports the survey results, and finally, some concluding remarks are offered in sub-section B.4.

B.2 Survey Design

The Contingent Valuation Technique was utilized in this experiment as it was throughout this paper. The theoretical construct of this technique was fully explained in Chapters 2 and 4, thus this section concentrates only on explaining the structure of the questionnaire used in this study.

The "commodity" to be considered here is visibility at the Grand Canyon National Park. To collect information through the survey technique,

the following steps were taken: the survey[3] was initiated with interviewers introducing themselves and presenting the purpose of the study. After the introduction, a detailed description of the Grand Canyon and the causes of poor visibility was given to each household interviewed. The respondents were shown a display of Grand Canyon photographs. These photographs represent five levels of visibility during morning and afternoon hours looking east and west from Hopi Point at the Grand Canyon. Column A represented poor visibility; B, below average; C, average visibility, D, above average and E, good visibility. in comparing columns respondents could see the variety of air quality conditions and resulting levels of visibility to be observed in the Grand Canyon. The rows represented the different vistas while standing at Hopi Point. The first row represented the different visibility and air quality conditions looking east, in the morning, Hopi Point. The second row represented morning conditions looking west, and the third row represented the view looking west in the afternoon from the same point. Past and future visitation by the household for the site was obtained by asking: how many days have you spent visiting the Grand Canyon National Park in the last 10 years? How many days do you expect to spend visiting the Grand Canyon National Park in the next 10 years? In the next step, respondents were asked to state their maximum willingness to pay in higher electric utility bills if the extra money collected would be used for air pollution controls to preserve current air quality and visibility levels at the Grand Canyon. We must note, that this constitutes a direct attempt to determine how much preserving visibility at the Grand Canyon is worth to the household. In other words, the household was asked to state willingness to pay by an increase in their electric utility bill to preserve current average visibility as represented in Column C rather than have the average deteriorate to that shown in Column B.

If willingness to pay (WTP) was zero, individuals were asked to check one of the following: (1) the air quality improvements represented in the columns were not significant, (2) the source of air pollution should be required to pay the costs of improving the air quality, or (3) other (please specify). Then the component value questions were deleted and the respondents were only asked a set of socioeconomic questions.

If the WTP was positive, then the interviewers were asked to proceed with the component value questions. This part of the survey was designed to "breakdown" the Preservation Value Bid into its four possible components. Consequently there are four reasons why the individuals might be willing to preserve the environmental quality.

a. The first reason you might be willing to pay for preservation is Actual User Value. That is, when you actually visit the Grand Canyon, you would rather have air quality at "C" rather than at "B". Thus, you should be willing to pay some amount to preserve air quality for each day of their own use if their recreation experience is improved by air quality at "C".

b. The second reason is Option of Use Value. Although you might be uncertain as to whether or not you will ever visit the Grand Canyon, you might be willing to pay to preserve your "Option of Use" to visit the

Grand Canyon under conditions represented by "B". Thus, you may be willing to pay an extra amount above User Value to insure good visibility at the Grand Canyon if you decide to visit.

c. The third reason is called Existence Value. Whether or not you ever visit the Grand Canyon, you are willing to pay solely to ensure the existence of air quality conditions at the Grand Canyon for the benefit of your generation as represented by "C" rather than those represented by "B".

d. The fourth reason is Bequest Value. This category is closely related to Existence Value as defined above, however, in this case, you must be willing to pay to preserve air quality conditions at the Grand Canyon for the benefit of future generations.

In the last part of the Survey every respondent was asked a set of socioeconomic variables in the following order: home zip code, place of residence (rural, suburban, urban), educational level, age, sex, size of household, whether the respondent was the primary income earner, household's yearly income, monthly electric bill, and finally, note if additional information was used.[4]

The Survey was conducted in Denver, Co. in the fall of 1981. 75 interviews were completed by three male/female pairs each equipped with identical picture boards. These were equally divided into high, low, and income families. the sample were chosen in a random fashion where income class variation was an important factor in determining the sample areas. Data from 1970 Census Tracts were used, and Table 2.6 describes, in detail, the areas sampled and provides some relevant Census Tract information.

B.3 Survey Results

This section presents results obtained from information collected in the survey described in the previous section. All values are "means" with "standard deviations" in parentheses. Past and future visitation for the Grand Canyon National Park is shown in Table 2.7. Among all respondents interviewed, 36.9 percent have visited the Grand Canyon, while 67 percent indicated they plan to visit the site sometime in the future. As was the case in previous experiments, past visitation had very little influence on bids, while future visitation plans did have some influence on bids for the Grand Canyon.

Table 2.8 presents the various socioeconomic and demographic characteristics of survey respondents. These variables are, number of observations, level of education, age group, size of household, yearly income (gross), and monthly electricity bill. Additional information not included in Table 2.8 were (1) 64% of the respondents were primary income earners, and (2) that 55% of the respondents were male.

Survey respondents were asked how much they would be willing to pay as an increase in electric utility bills to prevent average visibility deteriorating from situation "C" to situation "B". This "preservation value" bid is paid whether or not the respondent actually uses the Grand

TABLE 2.6

DESCRIPTION OF THE AREA SAMPLED FOR THE NATIONAL PARK SURVEY
DENVER METROPOLITAN AREA

Community/ Area	Boundaries of the Sample	Census Tract Number[a]	%Black[b]	Mean Income[c]
Denver	West: University Blvd. North: Alameda South: Mississippi East: Colorado Blvd.	39.01	.1	25,892
Denver	West: Holly North: 23rd Street South: Colfax East: Quebec	40.02	.1	21,000
Denver	West: Federal North: 19th Street South: 6th Street East: River	8	9	4,142

[a]Defined in the maps of, Census Tracts Denver, Colorado Standard Metropolitan Statistical Area: 1970 Census of Population and Housing U.S. Department of Commerce, Bureau of the Census, Publication PHC(1.)-56.

[b]From Table P-4, "Income Characteristics of the Population:1970," ibid.

[c]From Table P-1, "General Characteristics of the Population:1970," ibid.

TABLE 2.7

MEAN NUMBER OF DAYS FOR PAST AND FUTURE VISITATION

	Grand Canyon*
Past 10 years	2.41 (11.40)
Next 10 years	4.35 (11.57)

* numbers in parentheses are standard deviations

TABLE 2.8

SOCIOECONOMIC CHARACTERISTICS

	Number of Obs.	Education (years)	Age (years)	Household size	Income (yearly) x$1000	Electricity (monthly)
Denver	75	14.95 (2.37)	43.5 (14.62)	2.32 (1.05)	32.695 (21.74)	55.33 (42.30)

* numbers in parentheses are standard deviations

Canyon. The preservation value bid and its break down into: (1) user value, (2) pure existence value, (3) option value, and (4) bequest value is shown in Table 2.9. Of the respondents 67 percent are classified as users, while 33 percent are nonusers. Thus, the user value for the latter group is zero. bequest value is the largest and the user value is the smallest among these values. Schulze, et al. (1981) found that the user value is a small portion of the preservation value. Our experiment resulted in a user value which is approximately 8 percent of the preservation value. Therefore, among all these components, which sum up to the preservation value, for the Grand Canyon, the user value is the least significant.

Finally, if an individual was not willing to pay (i.e., zero bid), he was asked to check one of three reasons for a zero bid. They are: (1) the air quality improvements represented in the columns were not significant, (2) the source of air pollution should be required to pay the costs of improving the air quality, and (3) other (please specify). Table 2.10 illustrates the zero bids by reason for all preservation value respondents. A total of 16 individuals expressed a zero bid, and only two persons indicated "not significant" as their reason for bidding zero. This small number indicates that visibility at the Grand Canyon shown by the photographs is significant to the respondents.

B.4 Conclusion

The purpose of the experiment as developed in this chapter was to develop and apply the contingent valuation techniques in order to measure user, existence, option and bequest values. Schulze, et al., (1981) found that the annual preservation value of the Grand Canyon, nationwide, approaches 3.5 billion dollars, but user value is on the order of tens of millions of dollars. Thus, user value is only a small fraction of preservation value.

The respondents in this survey were divided into two groups: (1) non-users (participants who have never visited the site and have no future plans to do so), and (2) users (respondents who do have future visitation plans).

"User value" for non-users is, of course, zero. "User value" for users is $0.62 for an air quality improvement from "B" to "C". Brookshire, et al. (1982) recorded $1.08 for the same air quality improvement, this amount, however, included user and option value. Thus, in our study, the sum of option and user value would be $1.28.[5] Therefore, the results of this study are very close in comparison to those results determined by Brookshire, et al. (1982).

TABLE 2.9

PRESERVATION VALUE BID AND ITS COMPONENTS

Reason	Bid*
User Value	.45 (1.04)
Option Value	.67 (1.66)
Existence Value	1.42 (3.63)
Bequest Value	2.54 (5.25)
TOTAL Preservation Value Bid	5.09

*numbers in parentheses are standard deviations

TABLE 2.10

ZERO BIDS BY REASON AMONG PRESERVATION VALUE RESPONDENTS

	Not Significant	Source should Pay	Other	Total
Denver	2	5	9	16

REFERENCES

1. Additional information concerning the scientific basis of the photographs, causes of poor visibility, a listing of industrial facilities, and finally a map of the area was supplied upon request.

2. See page 78, paragraphs (a) and (c), of the report (Methods Development in Measuring Benefits of Environmental Improvements, Schulze, W.D., Brookshire, D.S., et al.).

3. The actual survey is given in Appendix C.

4. Additional information concerning the scientific basis of photographs, cause of poor visibility, list of industrial facilities, and finally, a map of the area was supplied upon request.

5. The Grand Canyon had 2,131,700 individual visits in 1979 or about 761,300 household entrances, assuming one household equals one carload. Using $1.08, the average household bid per visit to maintain visibility at level C--the current summer average rather than the poorer condition B, on the day of the visit--then $1.08 times 761,300 = $822,204. Using the $1.28 figure, the average household bid for the same air quality improvement, the result is ($1.28) * (761,300) = $944,012. Here again is another evidence for closeness in the results.

   Also, the aggregate of these values can be obtained:

   Aggregate User Value = (mean user bid) * (number of visits)
   Aggregate Option Value = (mean option bid) * (potential visits)
   Aggregate Existence Value = (mean existence bid) * (number of households)
   Aggregate Bequest Value = (mean bequest bid) * (number of households)

CHAPTER III

THE NATIONAL WATER QUALITY EXPERIMENT

A. INTRODUCTION

The aggregate bid experiment to be discussed below is motivated by both previously discussed experiments and raises the following questions. First, the disaggregate bid experiment focuses upon a specific, well-defined commodity for a small geographic region. Given the difficulties of aggregating such a bid, a question of interest becomes: is it possible to obtain a defensible aggregate, or national, bid for such commodities through the use of contingent valuation (CV)? Second, does the potential for obtaining national, aggregate bids depend on how well the CV commodity is defined? Specifically, can the aggregate commodity, "cleaning up the nation's rivers" (or air) be valued utilizing the contingent valuation method?

Thus, the primary purpose of the aggregate bid experiment is to evaluate the usefulness of applying the contingent valuation method to evaluating programs that are described generally and, additionally, have no unique geographic anchor in the description of the program. For instance, the improvement could be described as an average increase in air or water quality nation-wide. Such an approach is, of course, in direct contrast to the disaggregate experiment whereby as many dimensions of the contingent valuation mechanism as possible are specified. Given that Mitchell et al.[1] introduced the aggregate bid method as a means for estimating social benefits attributable to improving water quality in the nation's freshwater lakes and streams, their work will serve as a point of departure for the aggregate bid experiment reported here.

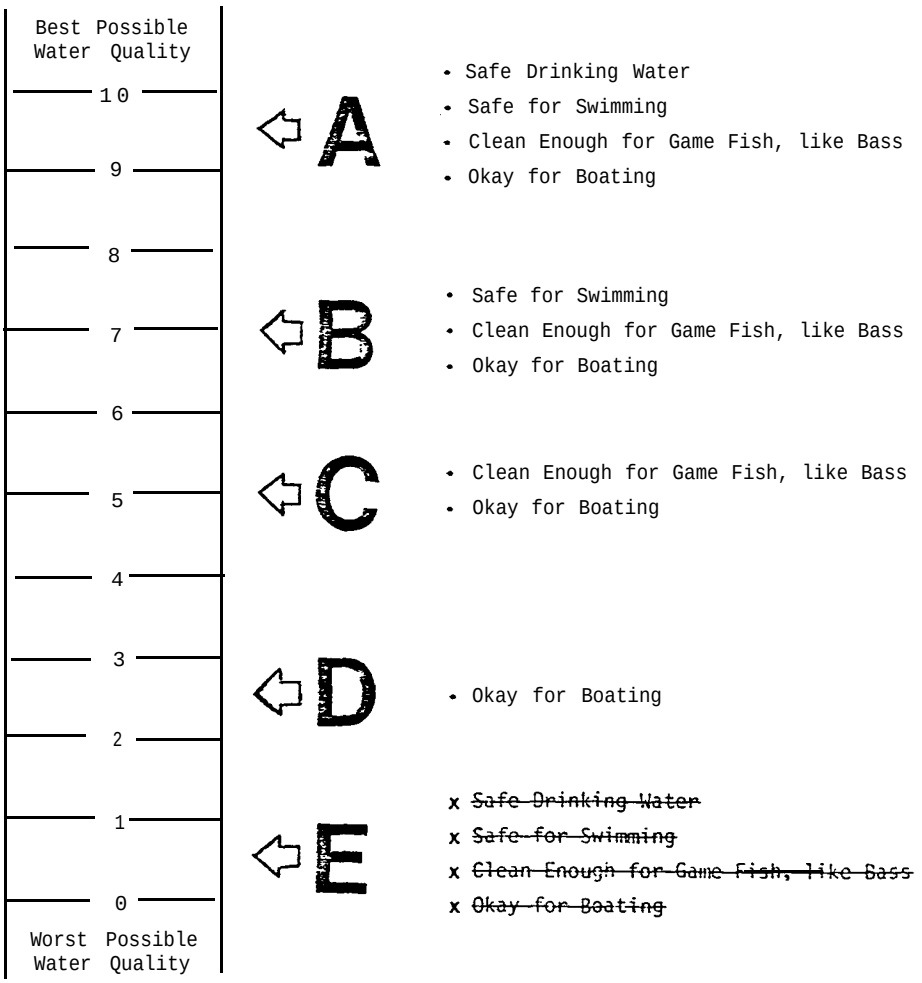
A.1 The Aggregate Bid Experiment and CV Instrument

The aggregate bid experiment involves the administering of a CV instrument, described below, to respondents in Denver, Colorado, during the period March 20-28, 1982. A complete set of CV instruments used in the aggregate bid experiment is given in Appendix E to this report. The basic structure of the CV instrument is as follows.

1. Following introductions and explanations of the purpose of the study, the water quality problem was defined via a water quality ladder (see Figure 3.1). The ladder defines the commodity "water quality" from a level "unsafe for drinking or boating" to a level safe for all activities (the current, average water quality level was described as level C in Figure 3.1). The basic survey format is the

Figure 3.1

Water Quality Ladder



same as that used by Mitchell and Carson except that in their study, the ladder describing water quality utilized pictures whereas water quality is verbally described in this study.[2]

At this point in the CV instrument, the respondent has been introduced to either a single commodity--i.e., water quality--or two different commodities--air and water quality. The CV instruments were further differentiated at this point by pursuing one of the following procedures:

2. An improvement in water quality from C to B is posited, coupled with a willingness to pay question. The respondent was handed a payment card to facilitate bidding.

3. A question is asked as to why the respondent bid zero if in fact they did bid zero.

4. Finally, demographic data was collected for: zip code, rural, suburban or urban, education level, age, sex, and size of household and primary income earner.

A summary of demographic characteristics for participants in the aggregate bid experiment are given in Table 3.1. Years of education average 14.7; average age is 38.9 years and, as expected, there is an inverse relationship between the percent who are female (52 percent) and the percent who are primary income earners (37 percent). Average sample size is 3.4 persons/household, and average monthly, after tax, income is $1,633.50 (standard deviation: $815.64).

The average (standard deviation) bid for the posited improvement in water quality was $6.50/month ($8.48). This value, comparative to bids obtained in the Mitchell study, will serve as our "baseline" bid against which will be compared effects of alternative changes in the CV instrument designed to induce "preference research" as explained above.

B. ADDING A BUDGET CONSTRAINT

In the aggregate bid experiment, the budget constraint is--as in the policy bid experiment--introduced prior to eliciting the individuals bid for improved water quality. The items included in the budget constraint are the same as those used in the policy bid experiment. For reasons that will be come apparent from our analyses of results, however, <u>two</u> different methods for introducing a budget constraint were used in this experiment: a "budget constraint" and an "extended budget constraint." The "budget constraint" method is identical to that used in the disaggregate bid and policy bid experiments. For the extended budget constraint method, a payment card is <u>not</u> used. The respondent is simply asked to rearrange his/her monthly expenditure pattern (information for which is acquired first) to reflect his/her maximum willingness to pay for the posited improvement in water quality--the individual, looking at his <u>current</u>

TABLE 3.1

DEMOGRAPHIC CHARACTERISTICS FOR PARTICIPANTS IN THE AGGREGATE BID EXPERIMENT

Sample Size:	217
Average Years of Schooling:	14.86
Average Age (years):	37.22
Percent Male:	56.53
Average Household Size:	3.26
Primary Income Earners (percent):	56.04
Average Monthly (after-tax) Income:	$1764.90

pattern of expenditures (Table 3.2a) fills out a new budget (Table 3.2b) payment card is not used. The respondent is simply asked to rearrange his/her monthly expenditure pattern (information for which is acquired first) to reflect his/her maximum willingness to pay for the posited improvement in water quality--the individual, looking at his current pattern of expenditures (Table 3.2a) fills out a new budget (Table 3.2b) where water quality is included as a budget item. Thus, we focus upon the effects of two different budget constraints in understanding the respondents "researching of preferences."

Table 3.3 (discussed later) presents the mean bids and mean income for the surveys divided into two groups for comparison of the effect of a budget constraint. Effects of introducing an additional public good upon a bid for a single commodity will be discussed in Section C. Since we are focusing in this section upon the effects of introducing a budget constraint to a bid elicited in the absence of a budget constraint the following comparisons are relevant.

- Water Bid versus Water Bid with Budget Constraint
- Water Bid versus Water Bid with Extended Budget Constraint
- Water bid with Budget Constraint versus Water Bid with Extended Budget Constraint

Focusing on the comparisons of bids, mean bids range from $6.50 for the national average improvement from C to B as described by the ladder in sub-section A.1, to $26.00 for a water quality bid obtained utilizing the extended budget constraint (Table 3.3). Thus from a rank ordering perspective, introduction of either type of budget constraint into the survey format in order to induce respondents to research their preferences would appear to increase the bids. Table 3.4 gives the deviations from the mean of water bids.

Examining Table 3.5, the water quality bid is statistically different utilizing a means t-test from the bid obtained utilizing either alternative budget constraint. Further, in comparing the results of the different type budget constraints a statistical difference is also found.

Thus in focusing individuals on trade-offs through the use of two different budget constraints the stability of the original water bid is in question except in one case. However, note that the bids did not decrease but in fact increased. This is in contrast to the policy bid experiment. where the introduction of a budget constraint lowered the unconstrained original bids. A possible explanation for the case at hand is that the introduction of the budget constraints only further confused respondents who did not view the commodity as being well defined. However, at this point no evidence is available to support this contention. The role of the commodity in these results, however, will be discussed in more detail in later sections.

C. ADDING OTHER PUBLIC GOODS

TABLE 3.2

BUDGET SHEETS COMPLETED BY RESPONDENTS IN THE AGGREGATE BID EXPERIMENT: EXPANDED BUDGET CONSTRAINT METHOD

-a-

FIRST BUDGET INFORMATION REQUESTED

Monthly After-Tax Income $_____

Allocation To:

Shelter (includes utilities) $_____

Food $_____

Recreation/Entertainment $_____

Savings $_____

Other $_____

-b-

BUDGET INFORMATION REQUESTED WITH WILLINGNESS TO PAY QUESTION

Monthly After-Tax Income $_____

Allocation To:

Shelter (includes utilities) $_____

Food $_____

/ Improved Water Quality / $_____

Recreation/Entertainment $_____

Savings $_____

Other $_____

TABLE 3.3

MEANS AND STANDARD DEVIATIONS (IN PARENTHESES) FOR THE WATER BIDS BY TYPE OF CV INSTRUMENT

Type of CV Instrument (Sample Size)	Mean Bid	Mean Income
Water (56)	6.50 (8.48)	1633.50 (815.64)
Water; Budget Constraint (25)	13.40 (13.65)	1646.20 (667.97)
Water; Extended Budget Constraint (28)	26.00 (26.29)	2070.00 (1116.91)

TABLE 3.4

DEVIATIONS FROM THE MEAN BY CV INSTRUMENT
(Mean = 13.38)

Type of CV Instrument	N	Deviation from the Comparison Group Mean
Water	54	-6.88
Water; Budget Constraint	25	0
Water; Extended Budget Constraint	28	12.62

TABLE 3.5

t-STATISTICS, DEGREES OF FREEDOM AND RESULTS OF THE HYPOTHESES TESTS CONCERNING THE EQUALITY OF ALL POSSIBLE PRICE OF MEAN WATER BIDS OBTAINED BY THE VARIOUS CV INSTRUMENTS
(t-statistics are given in absolute values)*

Type of CV Instrument	Water	Water; Budget Constraint	Water; Extended Budget Constraint
Water	----------	2.77 (79) Reject H_o	5.07 (82) Reject H_o
Water; Budget Constraint	----------	----------	2.15 (59) Reject H_o

* Let X_i = mean bid from the i^{th} CV instrument technique.

Then: in each cell we test

$$H_o: \bar{X}_i = \bar{X}_j \quad (i \neq j)$$

$$H_a: \bar{X}_i = \bar{X}_j \quad (i \neq j)$$

for example, H_o: mean bid obtained from the water only CV instrument are equal to mean bid obtained from the water; budget constraint CV instrument

H_a: they are not equal

The t-statistic is .48, the number of degrees of freedom are 110 and we fail to reject H_o.

The critical values for the t-statistic are:

2.58 - 99% level
1.96 - 95% level
1.65 - 90% level
1.29 - 80% level

$$Z = \frac{|\bar{X}_i - \bar{X}_j|}{S \sqrt{\frac{1}{n_i} + \frac{1}{n_j}}} \qquad i \neq j;$$

where: n_i = the size of sample i, i=1, ..., 6
X = pooled sample standard deviation

For the aggregate bid experiment, the "other" public good introduced as an alternative method for inducing "preference research" is air quality. To examine the effects of introducing air quality as a commodity on a bid for water quality, an air quality ladder (Figure 3.2) is introduced in conjunction with the water quality ladder (see CV instrument in Appendix E). Thus, in the policy bid experiment, the individuals maximum willingness to pay for the public good of interest (improved water quality) is elicited within a context wherein the individual's attention is focused on other environmental problems, the mitigation of which could also involve costs.

Table 3.6 presents the mean bid and income. Examining the mean bids and income for the effects of focusing individuals on other environmental problems, we see that all appear relatively equal; in applying a test of means this result holds statistically. That is, whether air quality is introduced into a water only or water; budget constraint or water; extended budget constraint we fail to reject the null hypothesis that the bid for water quality obtained without consideration of all other environmental problems is equal to a bid obtained in the context of an air quality bid.[3] The critical value for 90 percent confidence level is 1.65 while the t-values in order of the comparison in Table 3.6 are respectively .48, 1.33, and .13. Thus adding a public good does not affect the bid.

Figure 3.2

Air Quality Ladder

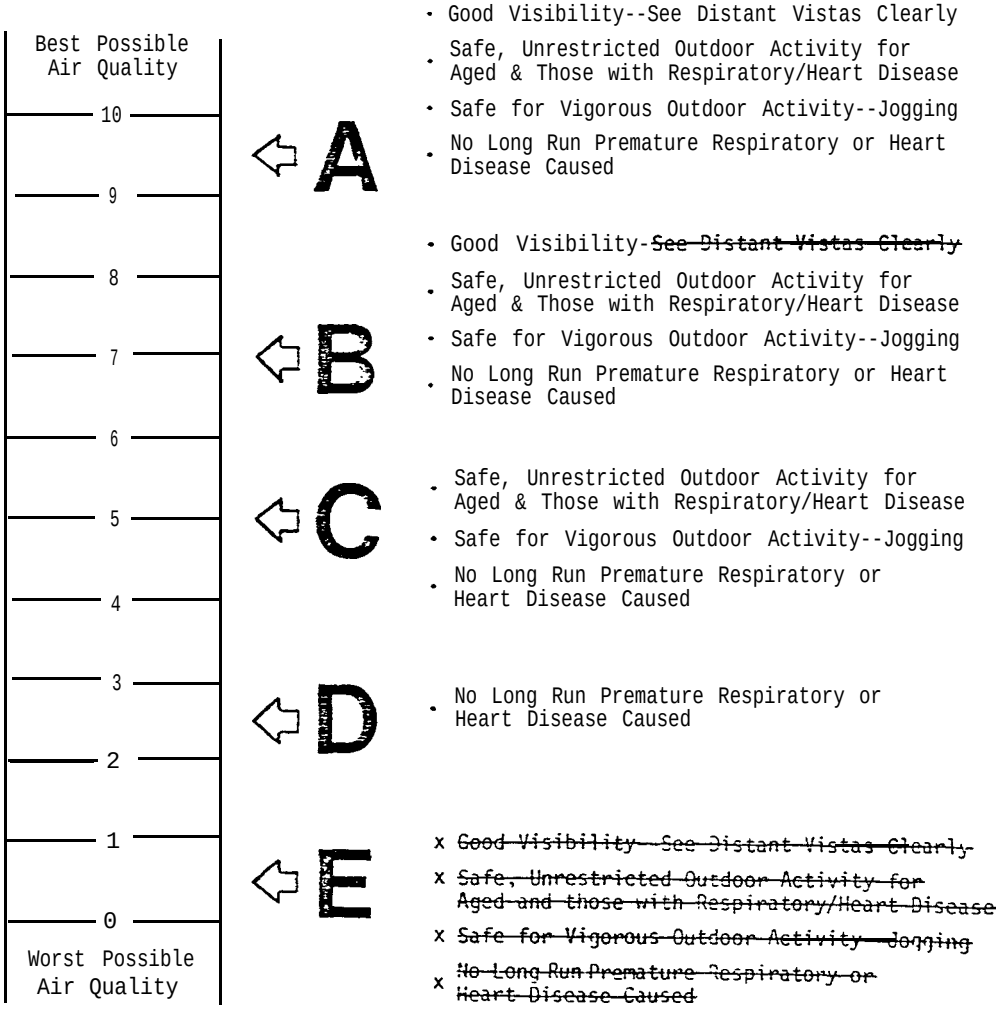


TABLE 3.6

MEAN AND STANDARD DEVIATIONS (IN PARENTHESES) FOR THE WATER BIDS BY TYPE OF CV INSTRUMENT

Type of CV Instrument (Sample Size)	Mean Bid	Mean Income
Water (56)	6.5 (8.48)	1633.5 (815.64)
Water and Air (56)	7.29 (8.29)	1623.8 (728.54)
Water; Budget Constraint (25)	13.2 (13.65)	1646.2 (667.97)
Water; Extended Budget Constraint (28)	26.00 (26.29)	2070.0 (1116.91)
Water and Air; Extended Budget Constraint (27)	24.9 (36.48)	2198.3 (1284.76)

REFERENCES

1. R. C. Mitchell and R. T. Carson, An Experiment in Determining Willingness to Pay for National Water Quality Improvements, Report submitted to the Office of Strategic Assessment and Special Studies, U.S.E.P.A. Contract #R-806906010.

2. The use of verbal descriptions was adopted to facilitate consistency with and "air quality ladder" discussed below.

3. For the structure of the test, see Table 3.5.

CHAPTER IV

TEE HAZARDOUS WASTE EXPERIMENT

A. INTRODUCTION

In the ozone experiment, reported on in Chapter V, as well as in the disaggregate bid experiments (Chapter II), the commodity used in the contingent valuation studies was relatively well defined. In the case where environmental risk was directly at issue (the ozone experiment), individual exposure to ozone and the effects of such exposure could be spelled out in considerable detail. In these instances where exposure and exposure effects were well defined, changes in contingent values attributable to changes in environmental risk (ozone levels) were consistent, in qualitative terms, with those that would be predicted from expected utility theory. Thus, while individual perceptions of risk associated with exposure to ozone are not, per se, measured in the ozone experiment--derivation of such measures is argued repeatedly in this volume as a vitally important next step in contingent valuation research--the framing of questions and information in the CV instrument seem to affect risk perceptions in a manner consistent with received expected utility theory. This observation may be important for future efforts to measure and explain risk perceptions as they relate to environmental risk.

There are many sources of environmental risk subject to regulation by the EPA which involve considerable uncertainty as to both exposure and exposure effects. One such source arises in the disposal of hazardous wastes. In the case of hazardous waste disposal, we know of cases where stored wastes have entered the environment; we know of cases where individuals have been exposed to uncontained wastes; and we know of instances where damages from such exposure have occurred (damages from ingested wastes by animals are documented; debate remains as to actual damages to humans, an area which we do not explore here). Notwithstanding these observations, we can specify with any degree of conclusiveness neither the nature, or probability of human exposure to hazardous waste nor the probability of damages that night attend such exposure. Thus, unlike the case with the ozone experiment, changes in environmental risk cannot be used as a commodity in a contingent valuation study of regulations on hazardous waste disposal.[1]

If one wishes to use the contingent valuation method as a means to estimate benefits attributable to more stringent EPA regulations on hazardous waste disposal (e.g., a total containment policy), one must then look to a CV commodity other than changes in environmental risk. One way of defining such a commodity is suggested in a recent work by Dr. Talbot Page.[2] Page poses the following dilemma facing society when uncertainty

exists as to exposure and exposure effects associated with toxic substances:

a. In the face of this uncertainty, we (the EPA) can regulate "today" and accept the associated costs. In the future, as more information and knowledge develops, we can find: (i) we were justified in imposing the regulation--the "dangers" in fact warranted the regulation and it's associated costs, or (ii) we were wrong, we overregulated, the "dangers" to public health and safety were not of an order of magnitude to justify the costs incurred as a result of the regulation.

b. We cannot regulate today, rather, we wait for more information. In this case, we can later find that: (i) we were justified in waiting--the dangers were overstated and we correctly avoided the (ex-post) unnecessary costs associated with regulation, or (ii) we were wrong, our waiting has exacerbated the threat to health and safety.

Page's dilemma may be interpreted in the following way for our purposes. The CV commodity is an action (or policy) which has the effect of a hedge against uncertain risks to health and safety. In valuing this action, an individual must weigh certain costs against uncertain benefits (avoided health/safety risks). Of course, an EPA regulation on hazardous waste disposal is such an action or policy; in what follows we then refer to a "policy commodity" the contingent valuation for which is called a "policy bid".

Whether or not the use of an EPA policy can serve as a viable commodity in a CV study is a question to be addressed in this chapter. The CV commodity aside, what is really at issue here, of course, is the viability of the CV method per se as a means for deriving credible values for an environmental good which cannot be defined with any degree of specificness. Our experiences with the CV method to date have almost always involved commodities amenable to specific definitions. These experiences lead us to anticipate the potential for framing-types of problems (see chapters V and II) in attempts to apply the CV method to commodities such as hazardous waste disposal which are lacking in specificity. Of course, questions as to the extent to which the specificity of the CV commodity might limit application of the CV method provide the raison d'etre for the experiments conducted in this chapter.

In this chapter, our concern with experimental approaches for valuing environmental commodities is extended to that class of commodities involving uncertain environmental risks, where regulations on hazardous waste disposal are used as a case study. The specific objective of this inquiry is that of addressing the following related questions. In cases where the nature of environmental risk is uncertain, and, therefore, individual perceptions of such risk are of paramount importance, can framing of the CV instrument affect risk perceptions (subjective probabilities)? Further, with changes in risk perceptions, are resulting changes in policy bids consistent, in qualitative terms, with those

predicted by established models of expected utility theory. Finally, do changes in the framing of the CV instrument result in policy bid changes that are consistent with changes deduced from received theory of value?

As in our earlier contingent valuation experiments with other environmental commodities, we do not attempt in this chapter to measure individual perceptions of risk associated with exposure and/or damages. We recognize the importance of such measures. However, we also recognize the importance of heuristic inquiries designed to provide the insights and data requisite for the formulation of informed questions and hypotheses that will be important in efforts to measure and explain risk perceptions as they are relevant for valuing changes in environmental risk. Thus, our study as to the potential viability of the policy bid approach proceeds within this exploratory context wherein insights and data are acquired via heuristic inquiry.

To the ends described above, the plan of our policy bid experiment and, therefore, the balance of this chapter, is as follows. In Section B we develop and motivate hypotheses which are to be tested from data obtained via a contingent valuation study based on the policy bid approach. Hypotheses related to these sets of issues are discussed. First, based on an expected utility model, we derive hypotheses as to changes in policy bids that should attend changes in subjective (perceived) probabilities related to exposure to and exposure damage from hazardous wastes (i.e., the subjective probability of hazardous waste containment and the subjective probability of damage from released, noncontained, wastes). Secondly, we develop hypotheses related to other aspects of individual preference structures, concerning environmental risk. As in our other experiments, primary concern here is with the framing of willingness to pay (WTP) questions and information as they might affect an individuals' process of preference research in arriving at contingent values. Third, and finally, hypotheses concerning interviewing and aggregation problems are discussed.

In Section C, our hypotheses are summarized and a contingent valuation instrument is designed for obtaining data required for testing the hypotheses. Results from the CV study and their applications to tests of hypotheses, are given in Section D. Conclusions are offered in Section E.

B. CONCEPTUAL AND METHODOLOGICAL ISSUES RELEVANT FOR EXPLORATORY ASSESSMENTS OF THE POLICY BID APPROACH

B.1 Hypotheses Drawn from the Expected Utility Model

Concern in the policy bid experiment is with a contingent valuation study wherein an EPA containment policy for hazardous waste disposal serves as the CV commodity. Given the above-described uncertainties surrounding the effects of such a policy, individual perceptions of two types of risks (their subjective probabilities) must underlie contingent values obtained in the CV study: subjective probabilities of waste containment with and without the EPA policy; and subjective probabilities of damages from noncontained wastes. Our a priori

expectations as to the behavior of policy bids as changes occur in these subjective probabilities may be derived from the following expected utility model of decisionmaking under conditions of uncertainty. (For an excellent discussion of the expected utility theoretical framework and its application to hazardous waste disposal, see Desvousges and Smith, 1982).

We define our notation as follows:

Let P = the subjective probability of containment of toxic wastes;

Π = the subjective probability of health damage if toxic wastes are not contained;

Y = consumer income;

D = level of health damage which the consumer believes will occur to him or herself if exposed to toxic wastes;.

$U(Y,D)$ = consumer utility, an increasing function of income ($U_Y > 0$) and a decreasing function of the level of health damage ($U_D < 0$);

and B = consumers bid (willingness to pay) for a government policy to contain toxic wastes.

Presumably a consumer will have a subjective probability for containment of toxic wastes even with no government policy, which we denote P°. A government policy to contain toxic wastes should raise this perceived probability to a higher level P^1. The willingness to pay for a waste containment program is in actuality a bid to raise P from P° to P^1. In the survey described below we obtain two bids for two levels of P^1 which are given to respondents by the interviewer as 50% and 100%. We now develop a model to predict the determinants of the bid, B.

The expected utility of a consumer where no government policy for containment of toxic wastes has been undertaken is

$$P^\circ U(Y,O) + (1-P^\circ)[\Pi U(Y,\overline{D}) + (1-\Pi)U(U,O)]. \qquad (4.1)$$

The term $P^\circ U(Y,O)$ is the probability of containment with no program times the utility in a state where health damage is zero (D=0). This is the expected utility derived from the state wherein no release occurs and consequently no health damage occurs. The term on the right-hand-side weighted by $(1-P^\circ)$, the probability of a release, is the expected utility in the state of the world where a release does occur.

However, it is not certain in this state that health damage must occur. Rather, consumers believe that if a release occurs, health damage of level $\overline{D}$ will occur only with odds Π. Health damage may be zero (D=0) with odds $(1-\Pi)$ even though a release has occurred. Components of expected utility in these two compound states are $(1-P^\circ)\Pi U(Y,\overline{D})$, expected

utility where a release has occurred and health damages result, and $(1-P^{\circ})(1-\Pi)U(Y,0)$, expected utility where a release has also occurred but health damages do not result.

Expected utility where a government toxics containment policy has been undertaken is identical to (4.1) above, except P^1 replaces P° and income is reduced from Y to Y-B so the consumer is paying \$B to achieve P^1 rather than P°. Thus we have

$$P^1U(Y-B,0) + (1-P^1)[\Pi U(Y-B,\bar{D}) + (1-\Pi)U(Y-B,0)] \tag{4.2}$$

as a measure of a consumer's welfare where a toxics program has been undertaken. If we set (4.2) equal to (4.1) and solve for B, we have the maximum willingness to pay of a consumer for a containment policy which the consumer believes will increase the odds of containment from P° to P^1. Further, if we totally differentiate the resulting equation we can solve for

$$\partial B/\partial P^1 = \frac{U(Y-B,0) - [\Pi U(Y-B,\bar{D}) + (1-\Pi)U(Y-B,0)]}{P^1U_Y(Y-B,0) + (1-P^1)[\Pi U_Y(Y-B,\bar{D}) + (1-\Pi)U_Y(Y-B,0)]}, \tag{4.3}$$

the rate of increase of the bid with an increase in probability of containment. The denominator is simply the expected marginal utility of money, $E(U_Y)$, i.e., the probability weighted marginal utility of money in different states, which is clearly positive. The numerator is the difference between the utility in the state wherein no release occurs and the expected utility wherein a release does occur. Clearly the individual is better off in the state wherein no release occurs so the numerator is positive. Thus, $\partial B/\partial P^1 > 0$ and the bid should be larger for policies which have a higher probability of containment.

Again, by totally differentiating the equation obtained by setting (4.2) equal to (4.1) we can solve for

$$\partial B/\partial \Pi = \frac{(1-P^1)[U(Y-B,\bar{D}) - U(Y-B,0)] - (1-P^{\circ})[U(Y,D) - U(Y,0)]}{P^1U_Y(Y-B,0) + (1-P^1)[\Pi U_Y(Y-B,\bar{D}) + (1-\Pi)U_Y(Y-B,0)]}, \tag{4.4}$$

the change in the toxics policy bid resulting from an increase in the perceived probability of health damage. Again the denominator is the expected marginal utility of money and is positive. However, the numerator defies easy interpretation. If the utility function is well behaved, a technique for approximating $\partial B/\partial \Pi$ is to approximate the utility function with a first order Taylor series expansion about Y and D=0 so

$$U(Y-B,D) \sim U(Y,0) - U_Y(Y,0)B + U_D(Y,0)D \tag{4.5}$$

and

$$U_Y(Y-B,D) \sim U_Y(Y,0). \tag{4.6}$$

Substituting (4.5) and (4.6) into (4.4), we obtain

$$\partial B/\partial \Pi \sim \frac{(P^{\circ} - P^{1})\, U_D \cdot D}{U_Y} .$$

Thus, as an approximation $\partial B/\partial \Pi > 0$ since $P^1 > P^\circ$, $U_D < 0$, $D > 0$ and $U_Y > 0$. This approximation is correct if D and B are sufficiently small so that (4.5) and (4.6) are in fact good approximations. In other words, an increase in the perceived probability of health damage if a release has occurred should raise the bid for a containment policy according to the expected utility model of consumer behavior.

Given the broad, exploratory scope intended for this study, we wish to test the two qualitative hypotheses suggested by the analyses given above, viz. that contingent values for the policy commodity rise as (i) the perceived probability of containment, (P) rises and/or as (ii) the probability of damages (Π) rises. Means for testing these hypotheses are sketched as follows (greater detail is given below in Section III).

Before continuing, a major point raised in Section I must be stressed. An effort is <u>not</u> made in this study to measure individual perceptions of risk per se. Prior to initiating the study, the authors were well aware of the importance of risk perceptions[3] for studies of behavioral responses to events involving risk. What was (and, to some extent, remains) not well understood is how such perceptions, along with other preference-structure-related behavior discussed below, might influence (in a qualitative sense) contingent valuations offered by individuals. Thus, as repeatedly stressed throughout this report, the primary intent of this study is that of exploring these issues--of amassing data which can provide a basis for hypotheses formulations in later phase efforts to directly address the <u>difficult</u> problem of deriving quantitative measures for perceived risk.

Returning now to the hypotheses stated above, the hypothesis $\partial B/\partial P > 0$ is examined in the following manner. In eliciting the WTP measure, individuals are told that the EPA containment policy will <u>totally</u> contain (100% containment) hazardous wastes; i.e., $P^1 = 1$. So long as individual perceptions of P with current disposal practices, P°, are less than 1 ($P^\circ < 1$), then we would expect a positive bid (call this bid MB for "maximum bid"). The individual is then asked to assume that the EPA policy is but 50% effective in assuring the containment of hazardous wastes--i.e., $P^2 = .5$. The resulting bid, FB ("fifty percent" bid) can be expected to have the following relationship to MB depending on the individuals perception of P°:

$$P^\circ \geq .5 \rightarrow FB = 0;$$
$$P^\circ < .5 \rightarrow MB > FB > 0.$$

Thus, if individuals perceive the probability of containment without the regulation as 50% or better, nothing is gained by the regulation and a zero

value would obtain for FB. If perception of this probability are less than 50%, a positive value for FB would be expected; with $\partial B/\partial P > 0$, FB would be less than MB (associated with $P^1 = 1$).

In terms of the second hypothesis, $\partial B/\partial \Pi > 0$, the following test is used. We assume that one's perceptions of the probability of damage from hazardous wastes that are not contained is influenced by--determined by--information (examples) as to incidents wherein such damages have in fact occurred. Thus, one set of study participants (set I) are given very little information in this regard. A second set of participants (set II) are given numerous examples of damage instances. Denoting SB as an individuals' "starting bid" (initial contingent valuation), we then compare SB_I with SB_{II}. Given our hypothesis drawn from expected utility theory wherein we assume $\Pi_I < \Pi_{II}$, we would expect $SB_{II} > SB_I$.

Thus, our inquiry as to the influence of perceived risk on contingent values focuses on questions with one common theme: can risk perceptions be "moved" by information--is information as to such things as containment and damage probabilities an effective determinant of perceived risks?[4]

B.2 Other Issues Concerning Preference Structures

There are three sets of issues/questions concerning the structure of individual preferences for environmental risk which are considered in this study; given the nature of these issues, our approach is necessarily heuristic. These issues concern instrument framing and preference research, environmental safety costs and contingent values, and demographic variables.

B.3 Instrument Framing and Preference Research

As in our disaggregate bid experiment (Chapter II), we wish to address issues concerning the framing of WTP questions in the CV instrument and the extent to which "framing" can affect the necessary process of an individuals' "preference research" if offered contingent values are to be meaningful. Following received theory of value, an individual, in choosing an optimal, budget-constrained comsumption set of goods and services, will examine all possible goods/services and their prices in arriving at an "equi-marginal" position where the ratio of marginal utility (MU) to price (P) is equaled for all goods/services which are consumed, This is to say that the trade-offs for MU/P for all goods in the feasible set are considered.

The context of the CV study, when the policy commodity is explained to the individual, the effect may be that of introducing to the individuals' feasible set of goods and services a new good--the individual has not previously considered hazardous waste regulations as a "good" in his/her consumption set. If the WTP question is framed simply as willingness to pay for the described commodity, one may well inquire as to the extent to which the individual has, in fact, considered the trade-offs implied by his/her offered valuation of the policy commodity; i.e., the individual may not, with this frame, consider the changes in his/her present

consumption/savings pattern implied by the contingent valuation, when one assumes (as the CV methods supposes that they do) that the offered valuation is in fact paid. Therefore, we wish to inquire as to the effect of different frames for the WTP question which relate to this preference research process involving the examination of trade-offs.

An issue which is inextricably related to the above concerns the question as to how individuals view any one, specific commodity. Received theory suggests that individuals view, and value, each individual commodity in their feasible consumption set. Thus, if an additional commodity is added to this set, that commodity is valued in its own right. However, recent work by psychologists,[5] suggest that individuals may view some commodity groups as a gestalt; i.e., individuals have "mental accounts" wherein similar commodities are grouped. Thus, as a simplification, in allocating income, rather than allocating $4.00 to a movie, $10.00 to a night at the bar, etc., an individual may simply allocate $14.00 to an "entertainment account".

The mental accounts notion has important implications for our study. If individuals do indeed view goods within a mental account context, the possibility exists that WTP measures for our policy commodity may well be more appropriately interpreted as a value attributable to a broader commodity (account): the individuals' "environmental safety account". The framing issue would then be most important--care must be taken to frame the WTP question in such a way as to focus attention one that one element in the environmental safety account of interest, viz., hazardous waste disposal (as differentiated form health/safety risks from air pollution, water pollution, etc.).

Before continuing, one should note that the mental accounts notion need not be necessarily at odds with the standard theory of value. The mental accounts notion may describe no more than a convenient process by which an individual thinks of goods/services at one level of abstraction--one sets aside, roughly, this amount of money for food, recreation, etc. When making actual expenditures, however, the account-level suballocation process may well cross account lines. Of course, this is pure conjecture and the relevance of the mental account notion remains as an open empirical question at this point.

Three alternative framing experiments are conducted in this study in an effort to gain insights as to the issues described above. These experiments are described as follows.

(i) We inquire as to the effect of framing the WTP question within a context wherein trade-offs between the policy commodity and goods/services in the individuals present consumption/savings pattern are made explicit. To this end, one set of participants (group A) are asked the WTP question in the usual way--explicit trade-off information is not given. For a second set (group B), prior to the WTP question, individuals are asked to reveal their monthly income and how this income is now spent in various expenditure/saving categories. The WTP question is then asked, along with the request that the individual indicate which expenditure category is to be reduced in order to facilitate the offered bid. With SB as the initial

(starting) bid, we then test the heuristic hypothesis $SB_A = SB_B$ in inquiring as to the effect of this type of framing.

(ii) When asked the WTP question, individuals offer a WTP from a payment card (described below). In an effort to induce individuals to give depth to their consideration of this offered bid, a "bidding process" is then used. Thus, given an initial, "starting" bid SB, the individual is asked to suppose that, with all households paying SB, resulting income would be insufficient to implement the proposed regulation; under these circumstances, the individual is asked if he/she would be willing to pay $1 more, then $2 more, etc., until a maximum willingness to pay is obtained. Denoting this latter, "maximum" value (bid) as MB, we then test the heuristic hypothesis MB = SB in examining the effects of an instrument frame which involves the bidding process.

(iii) Finally, we inquire as to the effects on contingent values for our hazardous waste policy commodity of making explicit the potential trade-offs with other environmental goods. Thus, cleaner air, cleaner water, etc., might be obtained if individuals were willing to pay more for these items. An offer to "pay" for the hazardous waste policy must then be considered in this context. In obtaining MB, we assume, as one typically does in a CV study, that these trade-offs are considered. This assumption is tested by framing the WTP question within a context where these "other environmental goods" trade-offs are made explicit. After obtaining MB, these trade-offs are described for the five environmental goods (including our hazardous waste disposal good) given in List 1, Table 4.1. Following this description, the individual is asked if he/she is still willing to pay MB; if not, an adjusted bid OG ("other goods") is obtained. The effect of framing the WTP question with explicit consideration of other goods is then tested with the heuristic hypothesis MB = OG.

The OG question has implications that extend hazard commodity trade-offs, however. It relates to the mental accounts notion: is MB a contingent value for our specific EPA policy on hazardous waste disposal or one for (for example) an "environmental safety account"? Suppose that MB > OG, i.e., when presented with other goods, the individual lowers his/her WTP for our specific policy commodity. This observation could be consistent with either standard value theory (more commodities over which to allocate income results in less income allocated to our specific commodity) or the mental accounts notion (with attention focused on the entire account, WTP for one component--our policy commodity--is smaller). Therefore, we examine the following, three heuristic hypotheses which are relevant in these regards.

First, we inquire as to whether or not OG is somewhat "mechanically" derived by simply dividing MB by 5 (the number of other goods in List 1, Table 4.1), i.e., $OG = \frac{MB}{5}$. If equality holds, the result would be weakly suggestive of the mental account notion. Most importantly, equality in $OG = \frac{MB}{5}$ might raise serious questions as to

TABLE 4.1

LISTS OF "OTHER PUBLIC GOODS" USED IN PRE-TEST PHASE

Goods Included In List		
1	2	Other Public Goods
X	X	Regulating facilities for permanent disposal of non-nuclear hazardous works
X	X	Regulating facilities for temporary storage of non-nuclear hazardous works
X	X	Regulating transportation of non-nuclear hazardous works
X	X	Regulating sites for nuclear waste disposal
X	X	Regulating transportation of nuclear works
	X	National Defense
	X	Improving Highway Safety

the extent to which OG is a thoughtful, reflective valuation, which is an important issue.

Secondly, in deriving OG, one set of participants (group 1) are given in List 1, Table 4.1, which includes only environmental goods. Another set of participants is given in List 2, Table 4.1, which includes List 1's environmental goods and the nonenvironmental public goods: national defense and improved highway safety. Ceteris paribus, standard utility theory would suggest $OG_1 > OG_2$[6] inasmuch as List 2 involves more goods which are introduced into the consumption set. The mental accounts notion may imply $OG_1 = OG_2$, inasmuch as national defense and highway safety are excluded from the environmental safety account. Thus, the heuristic hypothesis of interest here is $OG_1 = OG_2$.

Third, and finally, as was the case in a recent study by Tolley and Randall, the sequence of obtaining contingent values--SB then MB then OG--may bias the OG value. To test for such bias, the OG value is obtained from one group of participants in the sequenced manner described above--OG is obtained after SB and MB. For a second group of participants, the initial SB value is framed within the "other goods" context. Prior to eliciting the WTP, List 1 (Table 4.1) is discussed at some length and the point is stressed that the WTP applies to but one of many EPA regulations related to environmental safety: a regulation on hazardous waste disposal. Denote the initial and maximum contingent values derived with this question-frame as SB(OG) and MB(OG), respectively. We test the heuristic hypothesis MB(OG) = OG. Equality can be taken to belie the existence of a sequencing bias. MB(OG) < OG may imply (i) the potential for a sequencing bias and/or (ii) consistent with the mental accounts notion: the MB(OG) frame better assists individuals in "getting inside" the environmental risk account.

B.4 Environmental Safety Costs and Contingent Values

A second set of issues related to preference structures concerns the information set within which contingent values are derived. By this reference is made to the fact that many EPA regulations on environmental quality are now in place (including existing regulation on hazardous waste disposal) and that individuals are now paying for the existing state of environmental safety via higher taxes and higher prices for goods and services. The EPA regulations on hazardous waste disposal of interest here represents a marginal change in EPA-provided safety vis-a-vis these many. existing regulations. At issue is the question: is our CV measure marginal in this sense?

One method for gaining insights to this question is to inquire as to the extent that individuals are cognizant of the existing state of environmental safety regulations and the "price" that they are in fact now paying for this state. If such cognizance exists, or contingent value for the total containment policy of interest here is appropriately "marginal". Thus, in experiments wherein measures for SB(OG) and MB(OG) are derived, estimates for the amount that households in the participants' income class now pay for environmental safety are given to one set of participants (and

not given to another set) prior to eliciting SE(OG)--denote this value $SB(OG)^{COST}$. We then test the heuristic hypothesis $SB(OG) = SB(OG)^{COST}$ as a means for addressing this issue.

B.5 Demographic Variables

In looking to the determinants of contingent values for our policy commodity, we follow established practice in looking to the potential effects on preferences manifested in such values of demographic characteristics: income, age, sex, education, race and family size. In passing, we intuitively note the potential importance of family size (in this study, whether or not children under 18 are in the household) given the potential health threats associated with the hazardous waste disposal issue.

B.6 Methodological Issues

Two sets of methodological issues are considered in the policy bid experiment. The first concerns the choice of interviewing methods. The primary interview method used in this study is "intensive" in nature. Appointments for in-home interviews are prearranged by telephone some days before the interviewer visits the study participants home; typical interviews last 1½ to 2½ hours. This method is time consuming and costly. Given the necessary use of many visual aids (described in Section C) and the length of the CV instrument, however, the intensive method was considered desirable at the design stage of this project.

In one such study area (Houston, Texas), however, we experimented with the less expensive "extensive" method. Interviewers simply went door-to-door in preselected areas and requested individuals' participation as a CV study interviewee. Using the subscripts T and D to denote values drawn from the intensive, telephone-managed interviews and the extensive, door-to-door interviews, respectively, we then test for any differences in contingent values drawn form the two methods.

Thus, we test:

$$SB_T = SB_D$$
$$MB_T = MB_D$$
$$OG_T = OG_D$$

Secondly, we examine a methodological issue of considerable importance for efforts to derive national benefits estimates by aggregating over samples drawn from a few regions in the U.S. Here our interest is in the extent to which variables included in regression equations are sufficient to explain any differences in contingent values drawn from different cities (regions). The question as to comparability of contingent values drawn from three cities--Albuquerque, New Mexico, Houston, Texas, and New Haven, Connecticut--will be developed below.

C. STRUCTURE OF THE POLICY BID CV STUDY

C.1 Focus of the CV Study: Summary of Hypotheses

In assessing the potential viability of the policy bid approach as a means for obtaining contingent values for EPA regulations on hazardous waste disposal, arguments related to questions of particular importance for this assessment were developed above in Section B. These arguments suggested testable hypotheses, tests of which constitute the primary focus of this study. These hypotheses are summarized as follows (see notation, Table 4.2).

C.2 Hypotheses Concerning Perceived Risks

1. Is the policy bid for an EPA policy that is 100% effective in containing wastes (MB) the same as that for a policy that is posited to be only 50% effective (FB)?
   Hypothesis 1: MB = FB

2. Is the policy bid for a 100%-effective containment policy with "small" information-related perceptions as to the probability of damages from uncontained wastes (SB_I) the same as that obtained with "larger" information-related perceptions of such probabilities (SB_{II})?
   Hypothesis 2: $SB_I = SB_{II}$

C.3 Hypotheses Concerning Preference Structures

3. Does framing the WTP question within the context of explicit budget trade-offs affect the policy bid? (Subscripts A and B denote values from groups without and with budget information, respectively).
   Hypothesis 3: $SB_A = SB_B$

4. Does framing the WTP question within a "bidding" process elicit focus on trade-offs, thereby resulting in adjusted policy bids?
   Hypothesis 4: SE = MB

5. Does the explicit considerations of other (environmental) goods affect the policy bid?
   Hypothesis 5: MB + OG

6. Is the "other goods" bid, OG, simply the maximum bid (MB) divided by 5?
   Hypothesis 6: $OG = \frac{MB}{5}$

7. Is the "other goods" bid with only environmental goods (OG_1) the same as that obtained when environmental and nonenvironmental goods are considered (OG_2)?
   Hypothesis 7: $OG_1 = OG_2$

8. Does the sequence of introducing other goods affect the

TABLE 4.2

NOTATION

SB = initial starting bids taken from payment card--100% containment policy

MB = "maximum" bid obtained from the bidding process--100% containment policy

FB = value obtained when EPA policy is posited as but 50% effective in containing hazardous wastes

OG = contingent value for 100% effective containment policy when "other goods" are introduced

OG_1: only environmental goods introduced (list 2, Table 6.1)

OG_2: environmental non-environmental goods introduced (list 2, Table 6.1)

MB(OG), SB(OG) = MB and SB values obtained when "other goods" are introduced prior to the WTP question

$SB(OG)^{COST}$ = the SB(OG) bid when participant is given estimate of how much he/she now pays for environmental safety

AI: = average annual household income

AG: = participants use

RC: = race (white anglo-saxon, hispanic, black)

SX: = sex (male, female)

CN: = children under 18 in household (yes, no)

EN: = education (years of school)

Subscripts: (a) I. II: denotes values drawn from participant groups who are not (I) and are (II) given information related to probabilities of damages from un-contained hazardous wastes

(b) A. B: denotes groups who are not (A) and who are (B) given explicit budget information

policy bid?
Hypothesis 8: $MB(OG) = OG$

9. Is the policy bid a "marginal" valuation; does cost information affect the policy bid?
Hypothesis 9: $SB(OG) = SB(OG)^{COST}$

10. What demographic variables (average annual income, age, race, sex, children and education) significantly affect the policy bid?

For the equation:

$$MB = \alpha_o + \alpha_1 AI + \alpha_2 AG + \alpha_3 RC + \alpha_4 SX + \alpha_5 CN + \alpha_6 EN$$

Hypothesis 10: $\alpha_i = 0, \quad i = 0, 1, \ldots, 6$

C.4 Hypotheses Concerning Methodological Issues

11. Is there a difference between policy bids obtained from the intensive, prearranged interview method (SB_T, MB_T, OG_T) and those obtained with the extensive, door-to-door method (SB_D, MB_D, OG_D)
Hypothesis 11: $SB_D = SB_T$
$MB_D = MB_T$
$OG_D = OG_T$

12. Is there a significant difference between policy bids obtained in Albuquerque (Q), Houston (H), and New Haven (N)?
Hypothesis 12: $SB_Q = SB_N$
$MB_Q = MB_N$
$OG_Q = OG_N$

$SB(OG)_N = SB_Q$
$SB(OG)_N = SB_H$

Hypotheses 1 - 12 are to be tested using regression techniques. For hypothesis 3, for example, the regression equation takes the form

$$SB = \alpha_o + \alpha_1 D + \alpha Y + U \qquad (4.7)$$

where the dependent variable SB is represented by an (n+m) x 1 vector containing the n starting bids for group A and the m starting bids for group B, D is a dummy variable represented by an (n+m) x 1 vector of n zeros and m ones denoting whether the observation was drawn from group A or group B, Y is the respondents income, U is a random disturbance, and the α_1 are parameters. The parameter α_1 is interpreted as the income adjusted "group effect" on SB. That is, if the least squares estimate, α_1. If a_1 is <u>not</u> statistically different from zero, then one accepts the hypothesis $SB_A = SB_B$. If α_1 <u>is</u> significantly different from zero, D significantly affects the average bid and one <u>rejects</u> the hypothesis $SB_A = SB_B$.

Thus, for each hypothesis which compares one WTP value (W_1: e.g., SB, MB or OG) with another (W_2), the hypothesis that is statistically tested is H_o: $\alpha_1 = 0$. If t^* is the t-statistic for α_1, t_c is the critical value for t^*, then, for each hypothesis:

$$t^* \geq t_c \rightarrow \text{reject } H_o \rightarrow \text{reject } W_1 = W_2,$$
$$t^* < t_c \rightarrow \text{accept } H_o \rightarrow \text{accept } W_1 = W_2.$$

C.5 The CV Instrument

The structure of the CV instrument used in this study is described as follows. Given the length of the interview, a number of exhibits are used as visual aids to assist the interviewee's understanding of conversations (exhibits and figures used and referred to below are given in Appendix D).

1. Following introductions and explanation of the purpose of the study, hazardous wastes are defined (exhibit 1).

2. The pervasiveness of processes which generate hazardous wastes is explained (such wastes result from the production of many of the goods that we commonly consume, (exhibit 2).

3. The volume of wastes generated each year is mentioned (exhibit 3).

4. The disposition of these hazardous wastes is described, with emphasis on those wastes that are permanently disposed (exhibit 4); for group II, pictures of these disposal methods are also shown (figures 1-4).

5. Attention is narrowed to the issue of the permanent land disposal of hazardous wastes; in what follows, we ignore problems associated with treatment, temporary storage, transportation and, particularly, nuclear wastes (exhibits 5 and 6).

6. We then describe potential threats to public health and safety associated with the disposal of hazardous wastes (exhibit 7). Group II is given a description of such hazards accompanied by examples (exhibits 7-A through 7-F).

7. Attention is then focused on the uncertainty surrounding the hazardous waste disposal issue; uncertainty as to the kinds of wastes that can safely be allowed to enter the environment as well as quantities that can be released without toxic accumulations is described (exhibit 8).

8. Given these uncertainties, the regulate-don't regulate dichotomy is presented (exhibits 9 and 10).

9. The possible effects associated with the regulate-don't

regulate dichotomy--Page's "horns of the dilemma"--are then described (exhibit 11).

10. Given this context for uncertainty surrounding the need for and effects from the regulation of waste disposal, a total containment policy (to be in effect for 10 years) is explained and the individual is asked for a maximum willingness to pay to have the EPA policy initiated; the initial valuation or "bid" is chosen from a payment chart (exhibits 12 and 13).

11. Following the initial bid, we posit the case where, with all households paying this amount, the payments are insufficient to accommodate the regulation--"would you be willing to pay $1.00 more per month?" This bidding process is continued until a maximum willingness to pay is determined.

12. Uncertainty as to the effectiveness of the containment policy per se is then introduced. A maximum willingness to pay (following the procedure in 11) is then elicited under the assumption that the probability is but 50 percent that the containment policy will in fact prevent hazardous wastes from entering the environment (exhibit 14).

13. Attention is then returned to the containment policy that is 100 percent effective (exhibit 12), and the individual is reminded of his/her bid of $X to see this policy implemented. We then discuss other similar sources of environmental risk (exhibit 15), EPA regulations which could result in higher costs to the individual (via, e.g., passed on higher costs for goods and services). Given that willingness to pay questions similar to those asked here could well be raised concerning regulations related to items such as those in exhibit 15, the individual is asked if he/she would still be willing to pay the $X bid; if not, a maximum willingness to pay for the containment policy for hazardous waste disposal is elicited.

14. The interview terminates with responses to demographic questions:

    Annual household income
    Sex
    Age
    Race
    Education
    Children living at home (18 and under)

These 14 steps given above, along with the exhibits in Appendix D, describe the basic CV instrument given to group A study participants in Albuquerque and Houston (roughly, half of the participants in these cities). For group B participants in these cities, the following

information and questions are added to the basic CV instrument. Prior to eliciting the WTP measure in step 10, the individual is asked his/her monthly, after-tax income and how this income is allocated among the following categories (see exhibit 16).

Annual after-tax income	$_____
a. Shelter (including utilities)	$_____
b. Food	$_____
c. Recreation/entertainment	$_____
d. Savings	$_____
e. Other	$_____

The individual's bid is then elicited (step 10), along with the question: from which category, a-e, would you reduce expenditures in order to pay for the proposed EPA policy?

For reasons detailed in Section B, the CV instrument used in New Haven was modified vis-a-vis those described above. These modifications are described as follows.

(1) prior to step 10 (the WTP question), other environmental goods/regulations are discussed (exhibit 16)--we now pay for these existing environmental regulations.

(2) for half of the participants, stress is given to the fact that we are interested in making more restrictive only one of these many environmental regulations: hazardous waste disposal (exhibit 19). Step 10--the WTP question--is then used.

(3) for the other half of the participants, prior to (2), above, the participant is given an estimate of how much he/she now pays for environmental regulations (exhibit 17).

Referring to the basic CV instrument (steps 1-14, exhibits 1-15), this instrument represents the end product of pretests conducted in Albuquerque, N.M., during the period September 1-November 31, 1981. Major findings from the pretest, reflected in the basic CV instrument, were as follows.

1. Initially, "starting bids" of $1.00 and $5.00 per month were given individuals at step 10--the WTP question. Seemingly individuals associated starting bids with the actual cost of implementing a containment policy and final WTP valuations tended to cluster around the starting bid (either $1.00 or $5.00)--i.e., we encountered obvious "starting point bias".[8] This problem is corrected with the use of the payment card, exhibit 13, wherein individuals choose their own initial valuation.

2. Concern with nuclear waste disposal was pervasive in pretest interviews. Therefore, the exclusion of nuclear waste issues in this study is stressed in exhibit 6.

3. The regulation was posited as being in effect (exhibit 12) for 5

and 10 years. Resulting WTP valuations were found to be invariant to 5 or 10 years. Therefore, the 10-year horizon was uniformly adopted.

C.6 Implementing the CV Instrument

As the reader can now appreciate, the CV instrument is lengthy and considerable information must be communicated to the study participant. If the interviewee is to comprehend the WTP questions, time is required for the interviewee to ask clarifying questions, repetitions, etc., and the interviewer must be sensitive to whether or not the interviewee is following the conversation. As an aside, participants were generally very interested in the discussion and interviews averaged some 1½ to 2½ hours.

Reflecting these considerations, the decision was made to conduct interviews on a prearranged, appointment basis. This is the say that individuals were called at their homes and asked to participate in the study (see telephone script, exhibit 20). For those who agree to participate in the study, specific appointments were made and a "reminder" call was made at a later time. In Albuquerque and New Haven, phone numbers were taken from area phone books via a standard random number generator.

The technique used for drawing telephone numbers in Houston differed from the above. For Houston, the Research Triangle Institute, (RTI) selected survey areas which, based on census data, were to provide a stratified, representative sample of the Houston population (see Appendix E). The telephone exchanges for these areas were then used to form the pool of telephone numbers from which numbers to be called were selected via the random number generator. It must be recognized that for any particular demographic/economic area identified by RTI, its telephone exchange will in most cases include populations outside of the RTI area.

Finally, after completion of the appointment-arranged CV study in Houston, an effort was made to elicit participation in the CV study in 75 households on a door-to-door basis. In other words, if λ_i is the percent of the Houston sample which, according to the RTI sampling method, should come from area i, interviewers would enter area i and go from house to house for $\lambda_i(75)$ houses, conducting the CV study in those households which were willing to participate.

Success ratios for telephone-arranged appointments as well as for participation rates in the Houston door-to-door studies are given in Table 4.3; demographic characteristics of study participants are given in Table 4.4.

D. STUDY RESULTS

D.1 The Data

As described above, the policy bid experiment was conducted in three locations: Albuquerque, New Mexico (December 1, 1981 to March 1, 1982); Houston, Texas (September 15, 1982 to December 15, 1982); and New Haven, Connecticut (January 1, 1983 to March 15, 1983); data from

TABLE 4.3

CONTACTS AND PARTICIPATION RATES IN THREE STUDY AREAS

A. Albuquerque

Telephone Exchange	Number of Telephone Contacts	Number of Contacts Agreeing to Participate in study
24X	69	3
25X	81	9
26X	132	15
28X - 29X	258	21
34X	66	6
76X	15	0
82X	78	7
84X - 86X	33	4
87X	42	2
88X	72	6
89X	57	3
Total	903	76

B. New Haven

28X	201	21
24X	133	7
39X	257	23
38X	110	8
4XX	244	10
56X	24	1
78X	116	9
77X	166	10
86X	12	1
93X	18	0
Total	1,281	90

(Table 4.3 continued)

Table 4.3 (continued)

C. HOUSTON

RTI AREA	telephone prefix*	Door-to-Door: Number of Door-to-Door visits	Door-to-Door: Number of Households Willing to Participate in CV Study	Telephone Appointments: Number of Calls	Telephone Appointments: Appointments Made
21-04064	22X 465	2	0	35	02
21-11396	69X	3	0	63	4
21-12782	92X	2	0	47	4
21-15498	52X	2	0	31	3
21-18159	64X	3	0	39	5
21-27619	73X	3	0	49	3
21-45424	78X 72X	3	0	63	1
21-47548	77X	30	16	397	38
21-55790	86X	2	0	55	4
21-67008	462	3	2	60	4
22-15010	469	5	4	70	0
22-17395	472	2	1	59	5
22-22272	471	1	0	34	0
22-27095	498	6	1	50	5
22-34099	336	3	0	42	6
22-34570	258	6	0	53	8
Total		75	24	1,147	92

* The letter X indicates all 3rd-digit numbers

TABLE 4.4

DEMOGRAPHIC CHARACTERISTIC OF POLICY BID EXPERIMENT PARTICIPANTS

AREA	Sample Size	Average Annual Income*	Average Education*	Average Age*	Percent of Participants: Non-White	Female	With Children In Household
		(000)	(Years)	(Years)			
Albuquerque	74	$27.4 (14.8)	15.5 (2.4)	42.1 (15.8)	26%	35%	28%
Houston							
Intensive	89	44.9 (32.2)	14.1 (2.4)	41.6 (12.5)	9	33	51
Extensive	24	23.5 (13.0)	14.8 (2.5)	32.0 (8.4)	4	54	25
New Haven							
Set 1	44	30.2 (15.9)	15.0 (2.8)	45.0 (15.6)	5	41	50
Set 2	44	30.8 (17.2)	15.7 (2.2)	39.1 (11.6)	7	48	59

* Standard deviations given in parentheses.

interviews in these areas are given in Appendix F. The number of households that ultimately participated in the CV study is: Albuquerque, 76; Houston (prearranged interviews), 90; Houston (door-to-door), 27; New Haven, 90.

As with most studies of this type, results may be influenced by "outliers"--i.e., a few extremely high or low values which, if included in the data set, may bias analyses. One method for eliminating outliers is suggested in recent works by Desvousges, Smith and others.[10] The essence of this method is to eliminate any observation from the sample that has a disproportionately large effect on the estimated values $\hat{\alpha}_1$, $\hat{\alpha}_1$, or $\hat{\alpha}_3$. As applied in the present setting, the term "disproportionately large" was defined to be 30%. In other words, if after eliminating the ith observation from the regression, either $\hat{\alpha}_1$, $\hat{\alpha}_2$, or $\hat{\alpha}_3$ changed by 30% or more as compared with the values obtained in the sample, the ith observation was discarded. As shown, in the following table, however, few observations were treated as outliers.

AREA	ORIGINAL SAMPLE SIZE	ADJUSTED SAMPLE SIZE
Albuquerque, total		
Group A	44	42
Group B	32	32
Houston, total		
Group A	46	45
Group B	43	43
Houston, door-to-door, total	27	27
New Haven, total		
Group 1	45	44
Group 2	45	44

D.2 Average Measure for WTP

Average, income-adjusted measures for WTP drawn from the 3-city study are given in Table 4.5. Values given are for: the initial 'starting (or payment card) bid", SB; the "maximum bid" (which results from the bidding process), MB; the 'fifty-percent bid" (WTP when the EPA policy is posited as being but 50% effective), FB; and the "other goods bid" (WTP when other public goods are discussed), OG. Sets 1 and 2, for New Haven, refer to groups of participants who are not (set 1) and who are (set 2) given information as to their present outlays for environmental quality. All New Haven participants are given budget information. For Houston, "intensive" and "extensive" refers to prearranged appointment and door-to-door interviewing methods, respectively. Attention is now turned to an analysis of these data.

D.3 Affecting Risk Percentions in Contingent Valuations

Data in Tables 4.5 and 4.6 are relevant for hypotheses 1 and 2 concerning risk perceptions. In Table 4.6, the relevant t-statistic is less than the critical t for all cities in which case we fail to reject the hypothesis $\alpha_1 = 0$, which implies that we accept (fail to reject) the hypothesis MB = FB in all cases. Thus, contrary to the result consistent with hypotheses drawn from our expected utility model (MB > FB), the posited reduction from 100% to 50%) in the probability of containment does <u>not</u> result in a significantly lower bid--MB = FB, i.e., the bid is unaffected, in a statistical sense.

This apparent inconsistency between axioms drawn from expected utility theory and our survey results extends to perceptions regarding probability of damage as seen from data in Table 4.7. Again, we fail to reject the hypothesis $SB_I = SB_{II}$. An increase in information-related perceptions of the probability of damages does not, in contrast to hypotheses drawn from an expected utility theory model, result in an increase in the bid for 100% containment.

Obviously, one must interpret these results with caution. These findings may be viewed as indicative of any one or combination of the following explanations. First, the expected utility theory model (EU) fails in explaining behavior under conditions of uncertainty in this case. Secondly, our CV instrument fails in accomplishing its' intended purpose: affecting individual risk perceptions. In terms of containment probabilities (P in the EU model), the fact the MB is significantly greater than zero--that individuals are willing to pay for a 100% containment policy--supports the EU hypothesis $\partial B/\partial P > 0$. In asking individuals to assume that the policy is but 50% effective, the MB = FB finding may reflect things other than $\partial B/\partial P = 0$. For example, individuals may have perceived our 100% effectiveness statement as incorrect--around 50% is the best that one would expect. In the case of damage probabilities, it could well be the case that such perceptions are independent of information and/or simply that our framing of information failed to affect perceptions of damage probabilities.

In any of these cases, results in Tables 4.6-4.7 raise questions which require consideration as to the power of our EU models for situations involving environmental risk and, most importantly, the framing of questions/information used to affect perceptions of environmental risk. However, although not statistically significant, the sign of each of the relevant α coefficients is consistent with EU hypotheses developed earlier.

D.4 Instrument Framing and Preference Structures

Data in Tables 4.8, 4.9 and 4.10 are relevant for our efforts to examine the effects of changes in the framework of WTP questions on contingent values, as the framework might affect the individual's focus on trade-offs. Consistent with results in the disaggregate bid experiment (Chapter II), data in Table 4.8 supports the hypothesis that framing the WTP question within the context of explicit budget information does <u>not</u> affect the contingent valuation; it would seem that, in offering the contingent valuation, individuals are cognizant of implied private

TABLE 4.5

AVERAGE INCOME-ADJUSTED VALUES FOR POLICY BIDS
IN THE THREE-CITY EXPERIMENT

AREA	AVERAGE VALUE (standard deviation) FOR: (dollars per month) SB	MB	FB	OG
Albuquerque	$13.90	$21.32	$16.78	$14.20
	(17.23)	(26.37)	(24.69)	(23.01)
Houston				
Intensive	17.06	29.62	20.37	17.15
	(22.40)	(42.84)	(40.97)	(23.78)
Extensive	7.05	10.92	9.70	8.63
	(8.44)	(14.50)	(14.20)	(14.14)
New Haven				
Set 1	13.34	25.84	22.09	n.a.
	(17.22)	(31.34)	(31.96)	
Set 2	17.52	31.85	25.16	n.a.
	(20.55)	(36.36)	(35.94)	

TABLE 4.6

TEST OF HYPOTHESIS MB = FB

For Regression Bid = $\alpha_0 + \alpha_1 D + \alpha_2 Y$:

AREA	Coefficient Value for α_1	t-statistic	Critical to (90%)
Albuquerque	-4.55	-1.092	± 1.645
Houston	-9.36	-1.622	± 1.645
New Haven	-5.22	-1.043	± 1.645

TABLE 4.7

TEST OF HYPOTHESIS $SB_I = SB_{II}$

AREA	Coefficient Value for α_1	t-statistic	critical-t
Albuquerque (N=24)	2.18	0.23	± 1.721

TABLE 4.8

TEST OF HYPOTHESIS $SB_A = SB_B$

AREA	Coefficient Value for α_1	t-statistic	critical-t
Albuquerque	0.60	0.146	± 1.668
Houston	6.47	1.607	± 1.665

TABLE 4.9

TEST OF HYPOTHESIS SB = MB

AREA	Coefficient Value for α_1	t-statistic	critical-t
Albuquerque	7.43	2.058	± 1.645
Houston	12.70	2.790	± 1.645
New Haven	13.42	3.297	± 1.645

TABLE 4.10

TEST OF HYPOTHESIS MB = OG

AREA	Coefficient Value for α_1	t-statistic	critical-t
Albuquerque	-7.13	-1.779	± 1.645
Houston	-12.92	-2.718	± 1.645

goods/savings trade-offs (or, one might with to argue, they do not reflect on such trade-offs with or without explicit consideration of budget information).

The bidding process significantly affects contingent values as is seen from data in Table 4.9. This result is in contrast to that found in Chapter II's disaggregate bid experiment. Of course, a different CV commodity is involved in the disaggregate bid experiment and conflicting results may reflect differences in the specificity of the commodities. Further, one must be cautious in attributing the finding that the bidding process affects contingent values to the asserted cause: individuals' are induced to focus on relevant trade-offs. The finding may be indicative of other behavioral responses; e.g., the interviewee, when asked ". . . would you pay x-dollars more . . ." (see step 11 in the CV instrument), may feel that an adjusted bid is somehow "expected" from him or her.

From Table 4.10, we find that framing the WTP question within the context of other (environmental) goods results in a significant reduction in the contingent valuation--when attention is focused on trade-offs between our policy commodity (hazardous waste regulations) and other possible regulations affecting environmental safety, the contingent valuation for hazardous waste regulations is adjusted downward. Of course, this result is consistent with standard value theory as well as with the notion of mental accounts.

For reasons developed in Section B, we extend our analysis of how consideration of other goods affects the contingent valuation of one, specific good. First, we ask if the other goods-adjusted bid is simply a mechanical adjustment of the MB value; i.e., is OG simply MB divided by the number of other goods discussed in the CV instrument (5, see Table 4.1, List 1). That such is not the case is suggested by data in Table 4.11. The average value for OG is significantly lower than MB/5, a finding that is consistent with the argument that, in considering trade-offs between the hazardous waste commodity and other environmental commodities, the individuals mental preference research process vis-a-vis these trade-offs is discerning process.

Results given in Table 4.12 are striking in their possible inconsistency with value theory and their consistency with the mental accounts notion. Data described above suggests that the introduction of other environmental goods affects the contingent valuation (Table 4.10) and that such efforts reflect some degree of thoughtful differentiation between several environmental goods (Table 4.11). When still more "other goods" are introduced, but goods which are not related to environmental safety, the contingent valuation for the environmental good is unaffected. All else equal, value theory would lead us to expect a change in the contingent valuation as income is to be allocated over an expanded consumption set, in contrast to the result given in Table 4.12. The result is consistent either with the mental accounts notion, or with a rather extreme separability for environmental from other goods in consumers utility functions.

TABLE 4.11

TEST OF HYPOTHESIS OG = $\frac{MB}{5}$

AREA	Coefficient Value for α_1	t-statistic	critical-t
Albuquerque	-9.93	-3.657	± 1.645
Houston	-11.05	-4.375	± 1.645

TABLE 4.12

TEST OF HYPOTHESIS $OG_1 = OG_2$

AREA	Coefficient Value for α_1	t-statistic	critical-t
Albuquerque (N=50)	5.67	0.741	± 1.684

There are, of course, a number of possible explanations for the apparent inconsistency between Table 4.12 results and value theory. Individuals may be sated in these non-environmental goods at present, fixed outlays for the goods (equilibrium, equi-marginal conditions would be at issue here, however). They may feel that they can affect environmental goods but not the other goods. A weakness in the CV instrument in terms of affecting perceptions of the "other goods" may be an issue. At worst, we must conclude that Table 4.12 results raise questions as to how individuals assess values across heterogeneous groups of goods and that this issue warrants attention in future research. In this latter regard, it would be useful to extend this type of experiment to include many different types of goods-classes (possible mental accounts) in efforts to define the limits of "account" items (if, indeed, they are relevant) or further explore separability issues.

We next inquire as to the potential for a 'sequence bias" in obtaining other goods-adjusted contingent values. In the New Haven experiment, other environmental goods are introduced prior to the initial WTP question as opposed to being introduced after the derivation of SB and MB values in Albuquerque and Houston. At issue is the question: is the maximum bid obtained within the cost of other goods derived in New Haven (MB(OG)) the same as the "sequenced", other goods bid derived in Albuquerque and Houston (OG values)? Data in Table 4.13 present mixed results. As the 90% confidence level, the hypothesis MB(OG) = OG (α_1 = 0) is accepted (one fails to reject the hypothesis) for the Albuquerque experiment but is rejected in the Houston experiment. However, the failure to reject the hypothesis in the Albuquerque is marginal: one rejects the hypothesis at a slightly lower, 87.5% confidence level. Thus, the results supportive of the possibility of something of a sequencing bias in the OG contingent value.

Acceptance of the hypothesis that new Haven-type bids are significantly different (lower) than OG bids obtained in Albuquerque and Houston need not necessarily imply a "bias", however. Assume that individuals do, in fact, consider goods within the context of something like a mental account. From our earlier analyses, we would interpret MB (in Albuquerque and Houston) as a value relevant for an 'environmental safety" account and we then later, ask the individual to consider MB within the context of other environmental (we later "remind" the individual--call to his/her attention--of (to) these trade-offs). The individual must perceive the implicit emphasis on the fact that the hazardous waste regulation is one of many existing and potentially altered environmental regulations. While a "different" contingent valuation for the hazardous-waste regulation results, this relevant perception may be very different from that obtained in the New Haven experiment. In the New Haven experiment, the interviewer makes this emphasis explicit (see exhibits 16 and 19 used in New Haven). Thus, it may be the case that bid differences between the two experiments reflect differences in the individuals' preference research process relevant for getting "inside" the environmental safety account as opposed to a Randall-type sequencing bias per se.

The next issue related to preference structures addressed in this work concerns the extent to which contingent values for our policy commodity

TABLE 4.13

TEST OF HYPOTHESIS MB(OG) = OG

MB(OG) in New Haven Compared With OG Value In:	Coefficient Value for α_1	t-statistic	critical-t
Albuquerque	-8.82	-1.596	± 1.645 ± 1.554 (87.5%)
Houston	-16.28	-3.697	± 1.645

reflect an individuals' general awareness of what he/she is actually paying for environmental quality/safety at the present time. As discussed above, this issue is important for several reasons. In homey terms, if, in offering a contingent valuation, an individual fails to consider the wide range of existing regulations in place and what he/she now pays for the present environmental safety "state", the offered value may be meaningless at that later moment when he/she does consider the existing state. More formally, our interest is in valuing what is in fact a marginal change in the state of environmental safety and contingent values must be correspondingly "marginal" in nature.

In the New Haven experiment, half of the study participants (45) were given an estimate for the amount that similar (in terms of gross annual income) households now pay, in terms of taxes and higher prices for purchased goods and services, for the existing state of environmental regulations; the other half, of course, do not receive this information. The resulting contingent values are compared in Table 4.14: contingent values are seemingly unaffected by cost information. It would then appear that, in offering contingent values for our policy Commodity, individuals may be, in general terms, cognizant of the existing state of environmental regulations and the cost of maintaining this state.

In closing our analyses of issues related to preference structures and their implications for contingent valuations of environmental safety, we inquire as to the effects of demographic characteristics of individuals on this contingent valuation of our policy commodity. Results relevant for this issue are given in Table 4.15. As noted above, in the equation used for testing hypotheses involving bid comparison (equation 4.7), income is the only demographic variable included. Further, in all cases the coefficient on the income variable (α_2) is statistically significant (the t-statistic is well above the critical t at a 90% confidence level). When an additional five demographic variables are included in our equation, mixed results are obtained (Table 4.15). Income remains as a significant determinant of the MB contingent value in the Albuquerque and Houston experiments. In the Albuquerque experiment, contingent values are not significantly determined by other demographic variables. However, in the Houston experiment, the participants sex as well as their income is a significant determinant of the contingent valuation. Since the variable for sex in Table 4.15 is zero-one--zero for females, 1 for males--contingent valuations for the hazardous waste regulation are significantly higher for females than for males.

When Albuquerque and Houston data are pooled, two results are of interest. First, in the test as to differences between the regression equation with and without the pooled date, the f-statistic (99% confidence level) is $f_{6,126} = 2.8$; the calculated f-statistic is F = 1.97, in which case one fails to reject the hypothesis that the equations are different. This implies that the MB value drawn in Houston is not significantly different from the MB value drawn in Albuquerque. Secondly, and of relevance to our discussion above, income and sex are significant determinants of the contingent valuation of the hazardous waste regulation with the pooled Albuquerque/Houston data set.

TABLE 4.14

TEST OF HYPOTHESIS $SB(OG) = SB(OG)^{cost}$

AREA	Coefficient Value for α_1	t-statistic	critical-t
New Haven	4.04	1.013	± 1.665

TABLE 4.15

TEST OF HYPOTHESES OF DEMOGRAPHIC VARIABLE EFFECTS
ON CONTINGENT VALUES (MB-values)

	Coefficient Value (t-statistic) for Variables:					
AREA (critical-t)	Income	Age	Race	sex	Children	Education
Albuquerque (1.684)	.7(1.943)	-.4(-1.400)	-9.6(-1.015)	-3.4(-0.354)	-6.7(-0.733)	2.9(1.512)
Houston (1.66)	.7(4.851)	-.2(-0.446)	5.2(0.363)	-16.0(1.845)	-0.2(-0.022)	.2(0.131)
New Haven (1.665)	.1(0.432)	-.1(-0.208)	4.0(0.248)	-3.4(-0.486)	22.4(2.836)	.8(0.529)
Pooled Albuquerque-Houston (1.665)	.7(5.765)	-.3(-1.223)	-6.2(-.790)	-11.5(-1.779)	-2.6(-.413)	1.6(1.286)
Pooled Albuquerque-New Haven (1.665)	.3(1.779)	.03(.188)	1.2(.174)	.05(.011)	5.2(1.000)	1.3(1.245)
Pooled Houston-New Haven (1.665)	.3(2.813)	.1(.301)	11.7(1.271)	-1.7(-.305)	4.5(.830)	-.4(-.435)

In the New Haven experiment, income is not a significant determinant of the bid when other demographic variables are added to equation (4.7)--the existence of children in the participants household is the only variable that is statistically significant in explaining the contingent valuation. With the zero-one variable D gives zero's for no children, 1 for the existence of children in the household, the positive coefficient on the "children" variable indicates that contingent values for the hazardous waste regulation are significantly higher in households with children than in no-children households.

As in the case of pooled Albuquerque/Houston data, f-tests for regression equations with and without pooled data suggest no significant difference between data sets. The f-statistic (99% confidence level) relevant for comparing the New Haven/Albuquerque (Houston) regression is $f_{6,125} = 2.96$ ($f_{6,164} = 2.925$); the calculated f-statistic is F = 1.8726 (F = 0.959). With pooled data, only income is significant in determing the policy bid in Albuquerque/New Haven and Houston/New Haven. Thus, the case for treating sex as an important determinant of the policy bid is weakened when pooled data are considered.

All of the above points to the potential importance of income, sex and children in determining individual preferences related to regulations which affect environmental risk.

D.5 Results Concerning Methodological Issues

The final set of issues considered in this chapter concern interviewing methods and aggregation issues. Results from the Houston experiment which compares contingent values obtained from intensive and extensive (door-to-door) interviewing methods are reported in Table 4.16. In terms of starting, maximum and other goods bids for the hazardous waste regulation there is no statistical difference in bids obtained form the two interviewing methods. This result is particularly interesting within the context of experiments with data gathering methods conducted as a part of the ozone study reported in Chapter V. In that experiment, little statistical difference was found between contingent values derived from mail surveys and those derived form extensive, door-to-door interviews. In terms of costs per CV response, those from mail surveys are less costly than those from extensive methods which, in turn, are less costly than those derived from intensive methods. Thus, to the extent that results from the hazardous waste and ozone experiments are in some sense "transitive", lower-cost mail survey techniques may be viable for future CV studies concerning hazardous waste regulations. At this point, however, our data limit conclusions to the finding that, in the case of hazardous waste regulations, the lower cost extensive method yields results comparable to those derived form the intensive method.

In terms of the aggregation issue, results form tests of hypotheses concerning the comparability of contingent values obtained in our 3-city study are given in Table 4.17. As seen in Table 4.17, there is no statistical difference between income-adjusted bids obtained in Albuquerque and Houston (comparisons with New Haven values were discussed above; see

TABLE 4.16

TEST OF HYPOTHESES RELATED TO VALUES FROM INTENSIVE AND EXTENSIVE INTERVIEWING METHODS

AREA	Value of α_1 Coefficient (t-statistic) For Hypothesis: $SB_D = SB_T$	$MB_D = MB_T$	$OG_D = OG_T$
	(critical-t = 1.661)		
Houston	-2.24(-0.535)	-5.48(-0.661)	-2.39(-0.479)

TABLE 4.17

TEST OF HYPOTHESES RELATED TO BID DIFFERENCES BETWEEN CITIES

HYPOTHESIS	Coefficient Value for α_1	T-statistic	critical-t
$SB_Q = SB_H$	-3.04	-1.005	1.645
$MB_Q = MD_H$	-2.04	-0.369	1.645
$OG_Q = OG_H$	-2.04	-0.545	1.645

Table 4.13). This conclusion is supported by analyses described above wherein, using pooled Albuquerque/Houston data, bids adjusted for income and sex were not found to differ between the two cities.

E. CONCLUSIONS

The central questions addressed in the policy bid experiment concern the viability of the policy bid approach to measuring benefits associated with nonspecific, highly uncertain environmental risk, the effects of instrument framing on risk perceptions and other ideas related to preference structures and, more generally, the structure of major research problems which must be resolved in future research if the policy bid approach is to be used to generate estimates of national/regional benefits attributable to EPA regulations on hazardous waste disposal.

Subject to the caveats discussed below, results from this initial, explanatory research concerning the policy bid approach suggest, in the authors' view, considerable promise for the viability of this approach in applying the contingent valuation method. Lack of specificity in the CV commodity per se does not appear to introduce the magnitude of distortions that one might have expected a priori--although specificity-related problems exist as noted below. In this regard, the stability and comparability of policy bids across different regions and across different instruments, is encouraging (Tables 4.15 and 4.17). Study-participants seemingly grasp the substance of the policy commodity as well as the "marginal" nature of the commodity vis-a-vis the existing state of environmental regulations (Table 4.14). Further, the effects of changes in instrument framing are, in some cases, consistent with axiomatic behavior predicted by received theory as well as with results obtained from CV studies involving more specific environmental commodities (Table 4.8). Finally, lack of specificity in the policy commodity seemingly does not imply the need, as initially expected, for extensive, time-consuming, intensive interviewing methods.

A number of issues remain for further research, however. The most important of these, as we know at the outset, of course, is the need for measures of risk perception and changes in risk perceptions that are elicited in contingent valuation settings. This is to say that we need the capability of measuring perceptions of risk in the pre-commodity state as well as the perceptions that attend the policy bid offer. One conclusion from this experiment is made forcibly: we must understand the determinants of risk perceptions if the policy bid approach is to be made operational. The framing of risk changes used in this study, was not affective. Neither variations in the probability of containment nor (indirectly, via information) in the probability of damages resulted in significant changes in policy bids predicted by our expected utility model. These results could suggest problems with the expected utility framework. More likely, however, is the possibility that our a priori hypotheses as to determinants of perceived risk were faulty and/or or instrument frame failed to adequately communicate changes in risk. Thus, since individuals' perceptions of the "50% effectiveness" assumption may have been something

other than a ΔP; considerable attention in further research must be given to how one communicates incremental changes in risk; policy bids for 100% containment were, of course, consistent with expected utility theory.

Aside from, but relevant for, the risk perception issue, the question as to how individuals perceive the non-specific commodity in the contingent valuation process remains as an important issue. Here reference is made to the "mental accounts" notion: does the policy bid apply, as intended, to the specific policy commodity or to something like an environmental safety account? Our results show that individuals adjust their bids downward when the policy commodity is valued within the context of other environmental goods (Table 4.10) and that such adjustments are seemingly discerning in nature (Table 4.11); our results are mixed in terms of the potential for a sequencing bias in this adjustment (Table 4.13). However, policy bids adjusted for trade-offs with other environmental goods are the same as those adjusted for trade-offs with environmental and non-environmental goods--individuals seemingly ignore non-environmental public goods in adjusting their contingent valuation for an environmental good (Table 4.12). Obviously, results from one experiment in this regard does not make the case for the mental accounts notion; the case is made, however, for the need for further inquiry in this area. If bids reflect an individuals' "dumping" of an entire "account", we must understand why. Potentially troublesome framing questions would then arise as to how one induces individuals to consider one component in this account. Our efforts in this regard (Table 4.13) produce mixed results: emphasis on the marginal change in the environmental safety state represented by our specific policy commodity resulted in bids that were similar to those obtained without this emphasis.

Finally, the effects of our commodity's lack of specificity is seen in the sensitivity of bids to instrument framing. Similar to results obtained in the Disaggregate Bid Experiment, couching the WTP question within the context of explicit budget information, thereby calling explicit attention to trade-offs between the policy commodity and other private goods/savings, does not affect the policy bid (Table 4.8). Unlike the disaggregate bid experiment involving a more specific good, however, both the bidding process and the introduction of other goods results in significant changes in the policy bid (Tables 4.9 and 4.10). When the bid changes with each change in framing, one simply does not have a value which can be interpreted as a preference researched bid: still more changes in framing may result in still more adjustments in the bid. Further research is clearly required which focuses on the development of CV instrument the results in bids which are reasonably insensitive to changes in framing. In closing this chapter, we note a curious result from the research relevant for this framing issue. While bids do indeed change as the frame of the contingent valuation changes, bid changes are affectively similar in each of the three cities studied in this experiment.

REFERENCES

1. In the ozone experiment, changes in environmental risk are directly related to an EPA policy on ozone levels: lower ozone levels directly imply lesser exposure (risk) and, therefore, exposure damages.

2. See T. Page, 1981.

3. See our earlier work in Cummings, et al., April, 1981, Chapter 8; see also, Slovic, et al., 1983.

4. That such <u>is</u> the case is suggested by Slovic, et al., 1983.

5. See Kahneman and Tversky, 1982.

6. $OG_1 = OG_2$ could obtain in cases where individuals choose to allocate no more income to national defense and highway safety.

7. See Tolley and Randall, 1983.

8. See Schulze, et al., May, 1981.

9. Funding for initiating the Houston/New Haven phase of the study was delayed from March to September, 1982.

10. Desvousges, et al., 1982; their method draws on work reported in Belsley, et al., 1980.